

CA20NAF.6 B510 ENG



a31188005432360b

NON-CIRCULATING

Ref

510.527

SHELF No.....

630.4

059



ONTARIO AGRICULTURAL COLLEGE
LIBRARY

REFERENCE DEPARTMENT

THIS BOOK MUST NOT BE TAKEN
FROM THE ROOM

..... Nov. 19. 58

CA20NAF6

B510 -

B527



Digitized by the Internet Archive
in 2011 with funding from
University of Guelph

630.4
059

58515

BULLETINS

Nos. 510 to 527

Issued by the Ontario Department of Agriculture
Parliament Buildings, Toronto, Canada



ONTARIO

TORONTO

Printed and Published by Baptist Johnston, Printer to the Queen's Most Excellent Majesty

1958

BULLETINS

ISSUED BY

Ontario Department of Agriculture

Nos. 510 to 527

- 510—Capon and Caponizing
- 511—The Packing House on the Fruit Farm
- 512—Insects of the Apple and Pear
- 513—The Strawberry in Ontario
- 514—Let's Cook it Right *rev C 1/63*
- 515—Farm Ponds: Their Construction and Management *rev Aug 1/63*
- 516—Growing Winter Wheat in Ontario
- 517—Cattle Lice and How to Control Them
- 518—Oven Meals
- 519—Dairy Husbandry in Ontario
- 520—Modern Milk Houses
- 521—Farm Home Surroundings *rev Landscape Planning*
- 522—Insects Attacking Vegetables
- 523—Lime Acid Soils for Better Yields
- 524—Common Grain Smuts and Their Control
- 525—Bovine Mastitis
- 526—Greenhouse Vegetable Production in Ontario *rev ^{Rev} Jan 1/64*
- 527—Ontario Laying Flock Management

CA20NAF6
B510



CAPONS and CAPONIZING

By EARLE S. SNYDER

DEPARTMENT OF POULTRY HUSBANDRY
ONTARIO AGRICULTURAL COLLEGE
GUELPH, CANADA

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS • TORONTO, CANADA

TABLE OF CONTENTS

	<i>Page</i>
INTRODUCTION - - - - -	3
WHAT IS A CAPON? - - - - -	3
SLIPS - - - - -	3
CHEMICAL CAPONS - - - - -	4
AGE OF COCKERELS FOR CAPONIZING - - - - -	6
BREEDS SUITABLE FOR CAPONIZING - - - - -	7
CARE OF COCKERELS PRIOR TO CAPONIZING - - - - -	9
EQUIPMENT REQUIREMENTS - - - - -	9
THE OPERATION - - - - -	13
CAUTION - - - - -	15
OPERATING WITH THE ALL-IN-ONE INSTRUMENT - - - - -	18
OPERATING FROM ONE OR BOTH SIDES - - - - -	18
CARE AFTER CAPONIZING - - - - -	20
WIND PUFFS - - - - -	20
HOUSING, REARING AND MANAGEMENT - - - - -	22
RANGE REARING - - - - -	22
CONFINEMENT REARING - - - - -	23
BREAST CYSTS - - - - -	23
ECONOMICS AND MARKETING - - - - -	24

Prepared by Earle S. Snyder, Professor of Poultry Husbandry, Ontario Agricultural College, Guelph, Ontario, Canada, and published by the Ontario Department of Agriculture, Parliament Buildings, Toronto, Ontario, Canada.

CAPONS & CAPONIZING

Introduction

The art of caponizing chickens has been practised for centuries. References to the outstanding eating qualities of capons may be found in the literature of many countries. Epicures extolled their merits in ancient China and Rome, later in France, Britain and other countries of the West and still later in America, especially on the eastern shore.

Formerly a guarded secret, the practice of producing capons is now widely known, even routine in some areas, while the product — a luxury formerly available to the wealthy only — is now seasonally available to anyone in Ontario who enjoys good food and is willing to pay the relatively small premium in price which any quality product commands.

It is largely because of this reputed quality of the product and the premium in price often commanded that information concerning capons and caponizing is in such continuous and apparently growing demand. It is hoped that the following will supply all the necessary information.

WHAT IS A CAPON?

A capon is a male chicken that has undergone a surgical operation involving the complete removal of the sex organs, (*testes*). As a result the production of the male sex hormone is inhibited and the cockerel so treated either fails to develop certain male characteristics or, where already somewhat developed, tends to lose them. Secondary sexual characteristics, such as large comb and wattles, fighting tendencies, activity and general appearance become greatly modified. The capon's comb and wattles are small, its feathers rather long and loose. A capon is quiet — even sluggish, does not crow or fight, and in general becomes rather effeminate. Fig. 1.

Because of this quiet, rather inactive disposition capons may be raised to maturity with pullets without interference, or in flocks by themselves with little or no loss from fighting. In comparison, flocks of cockerels raised to roaster size often suffer considerable loss through fighting.

For the same reason, capons tend to fatten, or take on finish, better than cockerels and continue to add weight after cockerels have ceased doing so. The juicy, fine-textured flesh retains its tenderness and quality long after cockerels have become staggy and their flesh rather coarse, stringy and tough.

SLIPS

Where, as sometimes occurs, the two sex organs and their immediate surrounding tissue have not been completely removed, a certain amount of regeneration may take place with the result that some male hormone production will occur. Such individuals will develop male characteristics, the degree dependent upon the amount of testicular tissue remaining and on the age of the bird. They are commonly known as "slips" and, both when alive and when dressed, appear intermediate between cockerels and capons.



Fig. 1. A Barred Rock capon showing the characteristic head and feather condition.

Fewer slips develop when cockerels are caponized while still quite young. The testicles, capsules and a small section of each cord (*vas deferens*) are more easily and completely removed. This assures a perfect operation. In older stock the testicles become more firmly and closely attached to the body wall and because of this and their increased size are more likely to be crushed and incompletely removed, resulting in slips, as illustrated in Fig. 2.

CHEMICAL CAPONS

Male chickens may also be feminized by the use of both natural and synthetic feminizing hormones known as "estrogens", or with certain chemical compounds having a similar effect. The estrogen most commonly used is diethylstilbesterol. This is usually prepared in pellet or in a paste form and is either implanted or injected under the skin of the neck near the back of the head, by means of a metal implanter or ejector made for the purpose. Male chickens so treated show their greatest response, dependent upon the estrogen or chemical used, at from two to six weeks following an injection. Pugnacity disappears, crowing ceases and physical activity is greatly decreased while, at the same time, fat is put on. This is due to an increase of fat and fat-like compounds of the blood.

It is claimed that such estrogens can be effectively used in the more economical rearing of broilers and fryers and, even more so, with roaster-sized stock; also to tenderize old hens and cock birds. Similar claims are



Fig. 2. Heads of mature capon (1) cock (10) and slips (2 to 9), with the amount of testicular tissue found in the bodies of each shown in front of each respective beak. No. 2 would still be accepted as a capon. No. 3. Would have been at an earlier age. Nos. 7, 8 and 9 never did show capon characteristics.

Courtesy Kansas State Agricultural College.



Fig. 3. A healthy 3-4 week old cockerel — a good age and size for caponizing.

made for turkeys, especially turkey broilers or fryers. Young chickens treated with estrogens are known as “caponettes” because of their capon-like quality.

In Canada, however, the use of feminizing hormones with poultry is prohibited by the Canada Food and Drug Administration, the reason being fear of harmful effects on people consuming poultry so treated. As stated in Food and Drug Act, Division 22 B 22.009, July 1954 — “No person shall sell for consumption as food poultry to which has been administered any preparation having oestrogenic activity”.

Experimental evidence taken at the Poultry Department, Ontario Agricultural College, has shown that, while the estrogen used had a favourable effect on finish, roasting chickens so treated suffered excessive shrink upon being cooked.

AGE OF COCKERELS FOR CAPONIZING

The surgical operation may be performed at any age from ten days to six or seven weeks. The average poultryman will find three to four

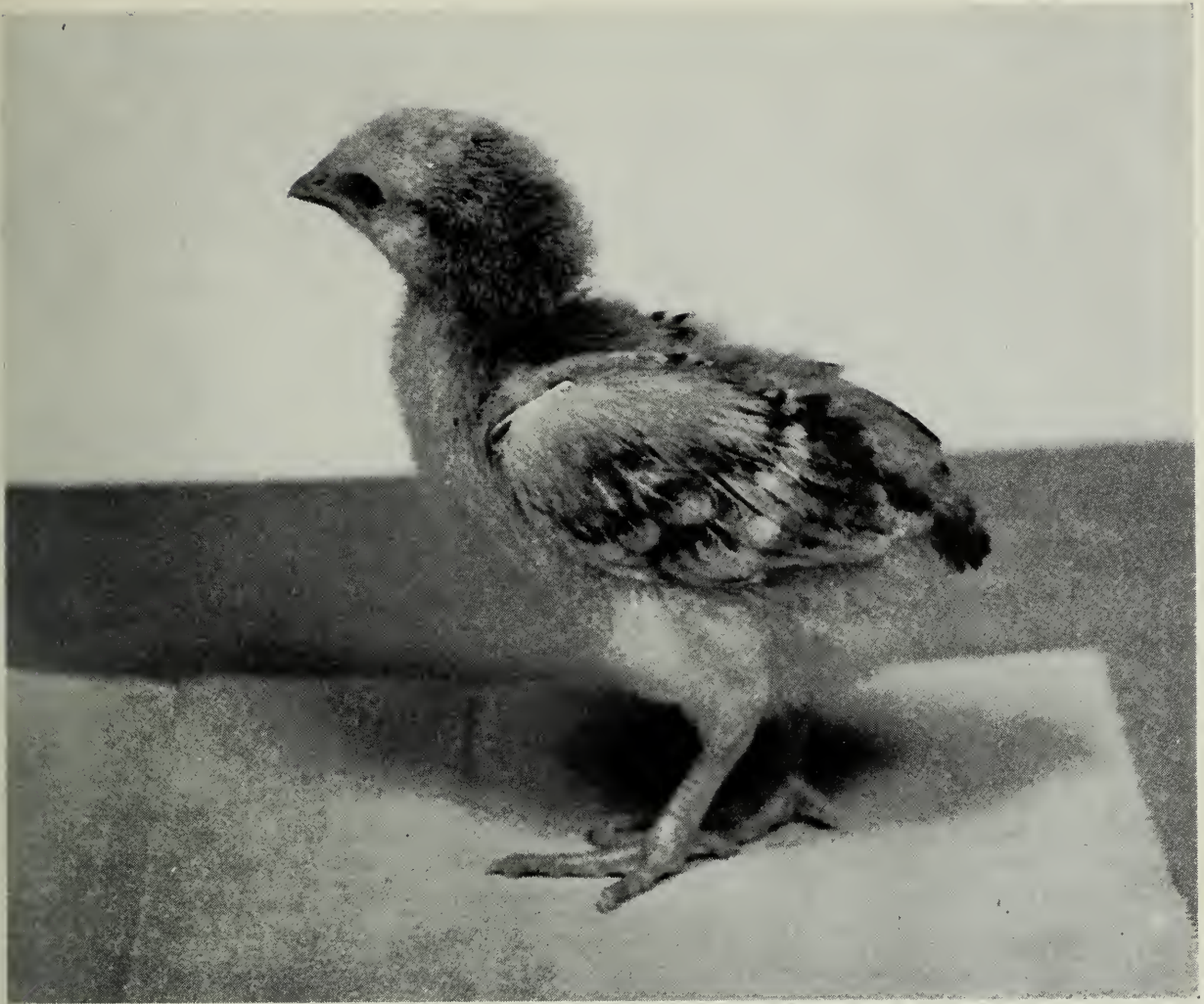


Fig. 4. Ten days to two-week-old cockerels may also be readily caponized. Some operators prefer such stock, claiming less loss and greater speed at this age.

weeks a satisfactory age as chickens are now grown, because the sex organs at this time are large enough to be easily seen and removed intact. (Fig. 3). In Ontario, however, most commercial caponizers operate at from ten days to two weeks as up to this time there is less likelihood of the presence of respiratory infections. Fig. 4.

Growthy, two- to three-week-old chicks, recover quickly from any shock incurred — more quickly than older stock — and so suffer very little set-back from the operation. There is also less haemorrhage. Moreover, if a chick is lost, less feed and other expense is involved than with an older individual.

BREEDS SUITABLE FOR CAPONIZING

Cockerels of any breed may be caponized. Fast-growing, meat-type breeds, strains and crosses are best, because of consumer preference for capons of good size — 6 to 8 pounds New York dressed. Light breeds and varieties such as S.C. White Leghorns if of good type, may also at times prove satisfactory where capon prices are high and if such stock is marketed not older than eighteen to twenty weeks. After this time their feed efficiency is too poor to allow any possibility of profit, even if the cockerels were secured free. Barred Plymouth Rocks make excellent capons because of their relatively rapid growth and thick fleshing of fine-textured,

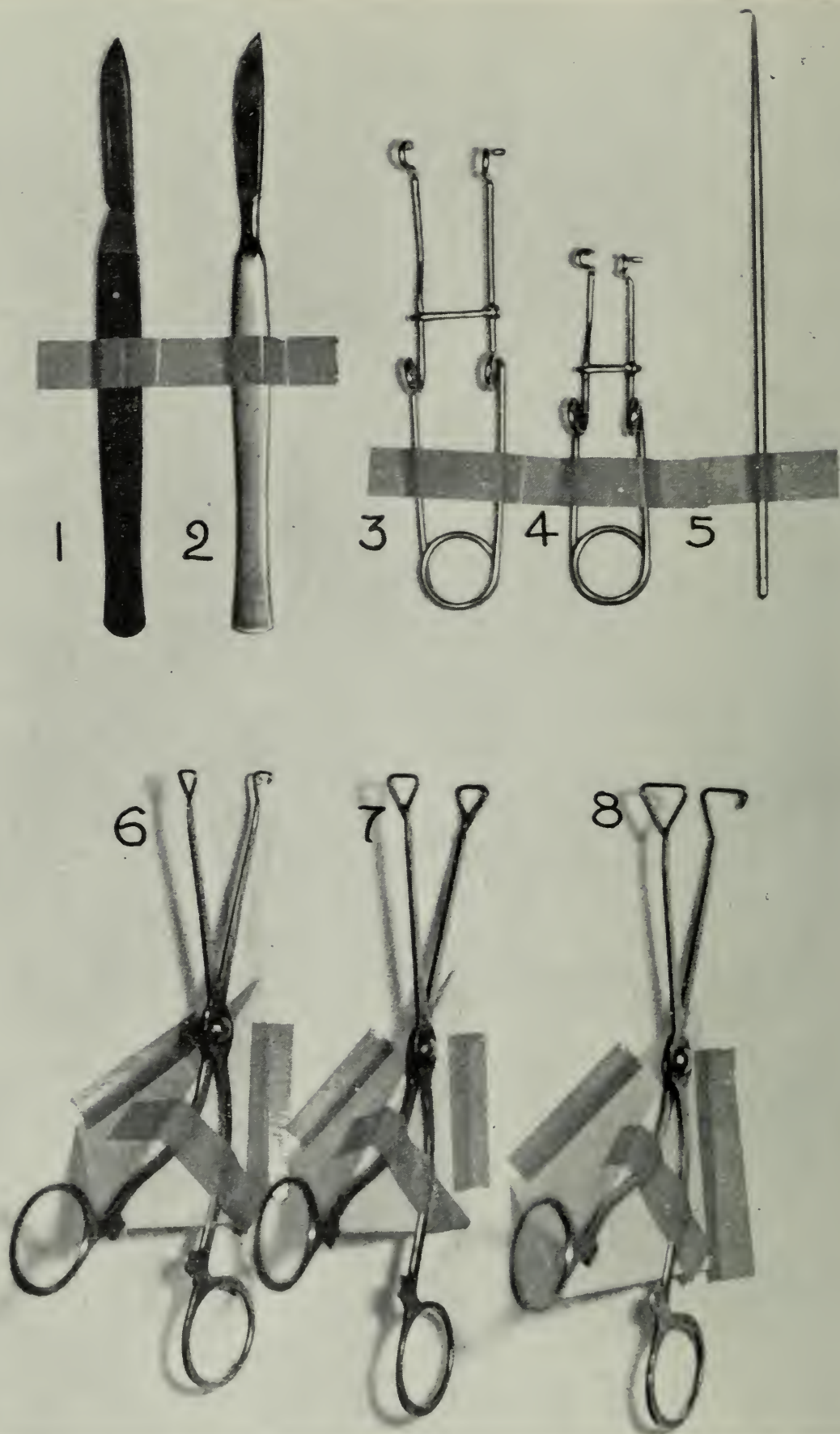


Fig. 5. One type of caponizing tools graded in size for use with cockerels of different ages.
 1 and 2—Scalpels, 3 and 4—Spreaders, 5—Hook and Probe,
 6, 7 and 8—Forceps graded for size of cockerel used.

high-quality meat. The present meat type, rapid-growing White Plymouth Rock is perhaps equally good. In fact cockerels of any breed, strain or cross will make satisfactory capons, provided they are fast-growing, develop thick-fleshed breasts and thighs and readily attain weights of from 6 to 8 pounds or more.

CARE OF COCKERELS PRIOR TO CAPONIZING

Cockerels for caponizing should be healthy, vigorous and growthy, free from any respiratory infection and from coccidiosis. They should be confined in clean, well-ventilated houses or batteries and not fed for twelve to fifteen hours prior to caponizing. This is enough time to empty the intestines, making it easier to operate. Water should also be withheld for at least the last six hours as this tends to slow down blood circulation and danger from haemorrhage. Removing the feed at about 5.00 p.m. and commencing operations the following morning usually proves satisfactory. Removing feed hoppers but leaving feed in the litter will often result in intestines distended with feed and difficulty in performing the operations. Empty intestines collapse out of the way and are not likely to "pop" out of the incisions, unless the incisions are made much too large. Over-starving weakens the cockerels, resulting in less rapid recovery and also in greater mortality.

EQUIPMENT REQUIREMENTS

1. *Caponizing instruments* — of which there are a number of makes. In general, these are of two types, electrical and non-electrical. Both types may be successfully used. It is claimed that the electrical knife and remover tend to cauterize the incision and the area from which the testicles have been detached; also that their use results in less haemorrhage and fewer slips. Much depends upon the operator. However, where two- to five-week-old cockerels are involved and speed and efficiency are major factors, non-electrical instruments in our experience have the advantages of being handier, much faster and also lower in initial cost.

Most caponizing sets consist of four instruments:

- (a) A small scalpel or knife, which should be capable of taking on and retaining a razor-sharp edge.
- (b) A spreader to hold the incision open while operating.
- (c) A combination probe and hook for tearing the air-sac membranes and for moving aside the intestines for better visibility if and when required.
- (d) A remover or forceps with which to remove the testicles. It is important that the spreader and forceps be made of light material such as an aluminum alloy and of such shape as to obstruct vision as little as possible. The forceps illustrated in Figure 5 have curved handles for this purpose. Spreaders and forceps of two or three sizes make it possible to use the one most suitable for the size and age of cockerels to be caponized at a given time.

2. A table or flat surface on which the cockerels may be tied down or held while being operated upon. This may be the top of a barrel, a chicken crate set on end or other makeshift. A better arrangement is a small hinged table on a stand or tripod, Fig. 6, or a simple tilting type



Fig. 6. A handy collapsible-type stand with revolving top. A wooden tripod will serve equally well.

made of two boards each about 12" x 18" in size and hinged together on the longer sides. This type may be set on a table at convenient height. A piece of broom handle or stick placed between the two boards will serve to elevate the operating surface to various angles as desired. Fig. 7.

Where time and speed are an important factor, a revolving table as illustrated in Figures 6 or 8, adjustable for height so the operator may



Fig. 7. An inexpensive stand. One cord with slip-knot around feet is attached to board at right. The other with slip-knot around wings is stretched to desired tightness and looped about wedge on end of board at left.

either sit or stand while working, will be found a convenience. Such table should have two sides or operating surfaces to enable an assistant to fasten down or remove one bird, as the case may be, while the other is being operated upon. Cleaning and sanitation are facilitated by having the operating table tops painted with a gloss paint or covered with white oil cloth.

3. A small dish containing water or a mild disinfectant. Figs. 6 and 7. This will serve to hold instruments and keep them clean while not in use during the operation; also for moistening the areas where incisions are to be made.

4. At least two boxes, crates or batteries conveniently placed — one to hold the supply of cockerels and the other receive the capons. Fig. 8.

5. Good light — without which satisfactory work is impossible. Without good light it is difficult to locate and clearly see the sex organs for removal, also to make sure later that every bit of the organs has been removed.

A bright sunny day is best and the operator should set up his equipment where the sunlight will shine over his shoulder directly through the incision into the body cavity. Inside a south or west window may serve well, or even outdoors.

A surgeon's headlamp or a headlamp made from a focusing flashlight head fastened by a band to the operator's forehead and attached to batteries nearby (as e.g. under the operator's chair) will give excellent illumination where most needed. Fig. 8.

Another simple, but excellent source of light is a clear glass sealed-beam lamp or spot-light hung at a convenient height over the stand on which the cockerel is placed while being operated upon. Fig 6.

Good light aids greatly in preventing slips. It is particularly important for young birds. Beginners are well advised to work only in good light.



Fig. 8. A complete operating unit for commercial work including revolving table with automatic chick counting attachment. A helper ties down and removes the birds enabling the operator with headlamp and all-in-one instrument to operate at high rate of speed. Cockerels are taken from chick box; they are placed in battery when caponized.

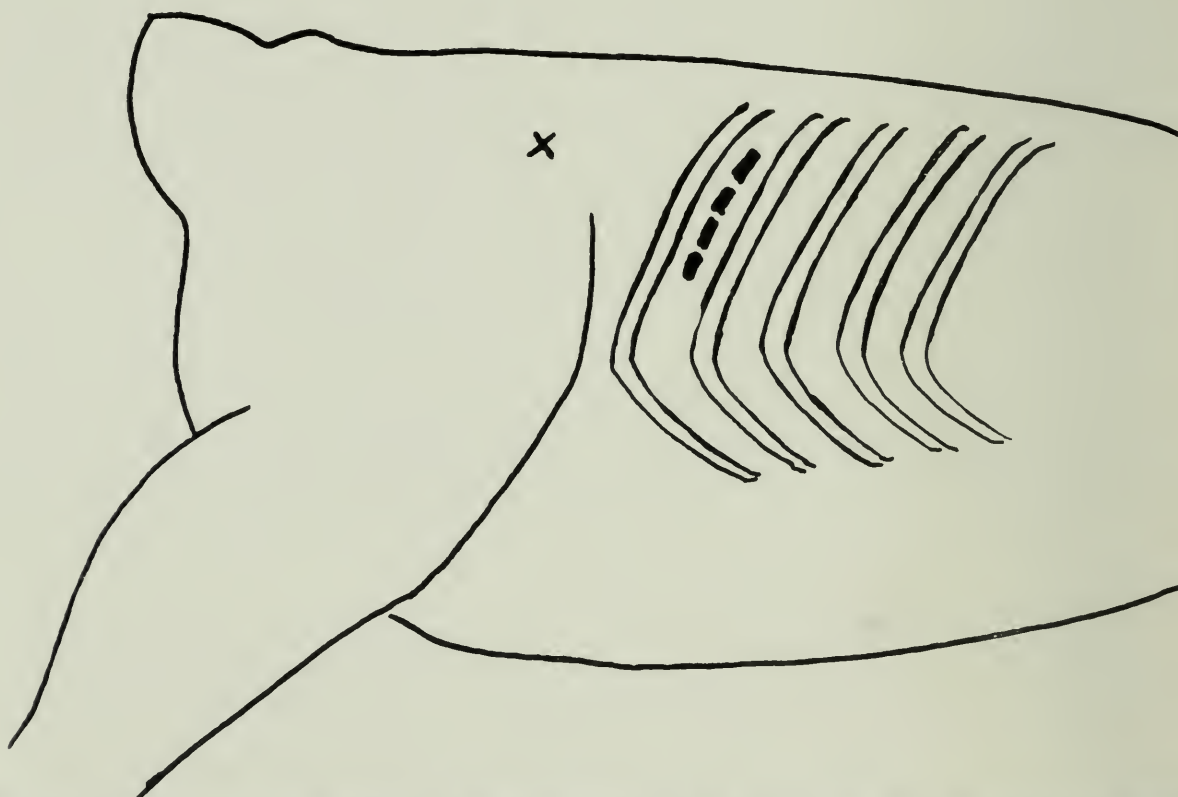


Fig. 9. The dotted line shows the location of the incision between the last two ribs, the X the position of the hip.



Fig. 10. Skin drawn to one side and tightly held between thumb and forefinger and showing point of incision.

THE OPERATION

The starved bird is stretched on its right side on the operating table as shown in Fig. 7, and fastened securely, being careful to stretch tightly, but not too much so. Having the bird in the correct position on the table assists greatly in properly aligning the internal organs for greatest ease in operating. A few quick pulls will remove any down, pin feathers or feathers from an area over the posterior ribs and just in front of the hip bone. Young chicks need little plucking, which saves time. The plucked area and surrounding feather growth are now moistened by means of the fingers or a small sponge dipped in a weak disinfectant solution. With the fingers of the left hand the intercostal space between the last and second last rib is located (Fig. 9), the skin is drawn forward from the hip and tightly stretched between the left thumb and forefinger (Fig. 10). With the razor-edged scalpel held between the thumb and forefinger, the skin is laid open in one stroke, then the knife is reversed and the point is pricked through the muscle between the ribs at the lower end of the skin incision and is run upwards to a point just in front of the hip. The incision will be from $\frac{3}{8}$ to $\frac{3}{4}$ of an inch long, depending on the age and size of the chick. The spreader is then carefully inserted (Fig. 11). Properly made, the incision will extend up to the posterior air sac wall, exposing and opening slightly the lower edge of the sac. This air sac is situated just inside the opening. With knife or hook, tear through this thin tissue far enough to expose the testicle; it may also be necessary to lengthen the incision in some cases. With practice one can open the bird and air sac without use of either probe or hook and so save time. Slitting the skin first exposes the thigh muscle which can be moved aside with the knife point



Fig. 11. Three-week-old Barred Plymouth Rock cockerel opened and with spreaders inserted.

making possible an incision between the ribs without undue damage to muscle tissue. This facilitates quick healing. Drawing the skin forward tends to avoid severing the long radicle of the large cutaneous vein which crosses the body diagonally from the thigh to the wing. Severing this vein, while not serious, often causes sufficient haemorrhage to confuse the beginner by obstructing his vision; a bit of absorbent cotton will remove any blood. With practice the incision can easily be made with no haemorrhage and little pain.

If the incision has been properly made and the intestines are collapsed from starving, the left testicle will be in plain view just below the front end of the kidney (Fig. 12). It will vary with the bird in size, shape and colour, but is more or less bean shaped and usually yellowish grey in colour. Sometimes the testes are partly or completely black in colour and more difficult to see. Such organs are not diseased and would develop normally and become functional in mature males. The operator will soon learn to accurately distinguish the organ, regardless of shape or colour.

Almost directly below the upper or left testicle will be the lower or right testicle separated from it by a thin membrane; raising the upper organ will expose the lower one to view. Some operators rupture the membrane and remove the lower and then the upper organ from the one incision. It is, however, more difficult to accomplish and the beginner will find it easier to make incisions on both sides and remove one testis through each incision. Some of the speediest and most experienced and successful operators do the work in this way, especially with two- to three-week-old cockerels. It is difficult to grasp the lower testicle with the forceps unless

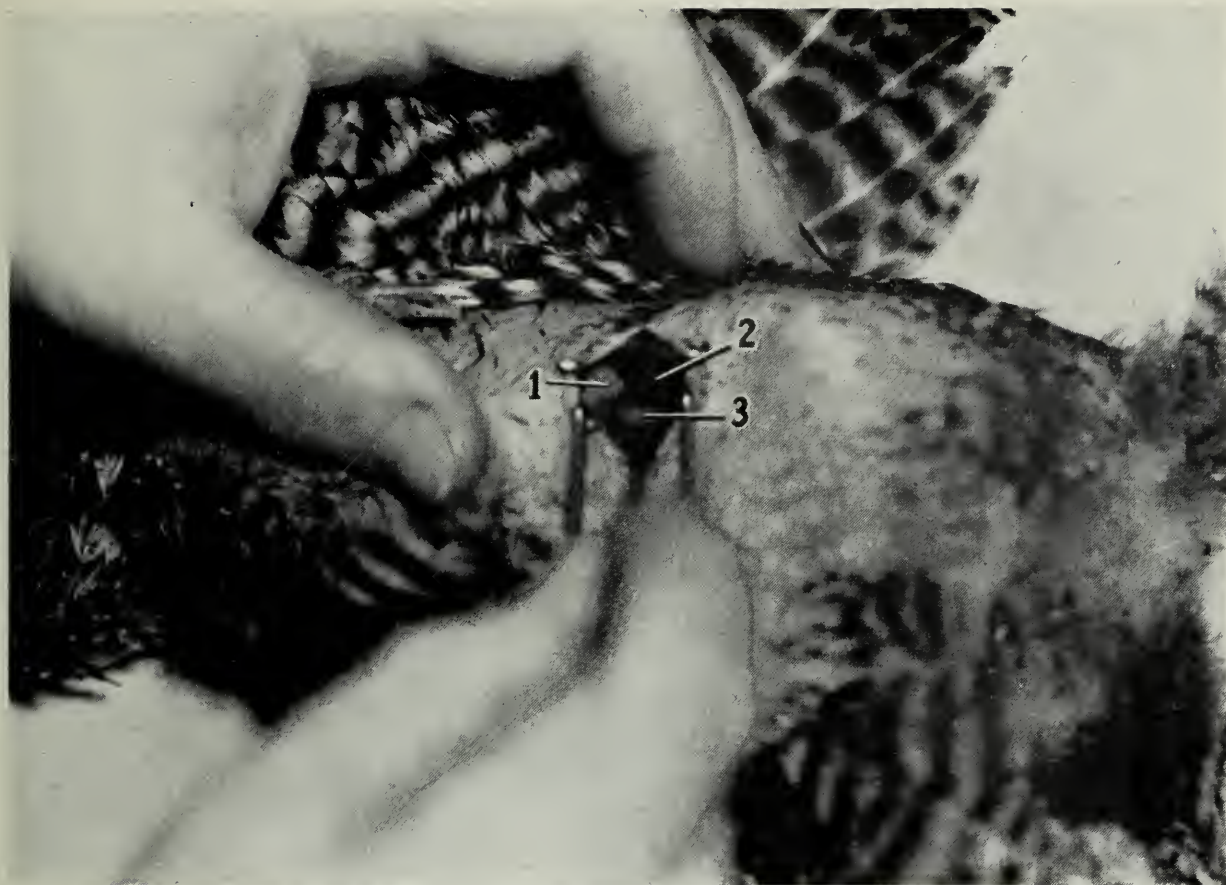


Fig. 12 Six-week-old cockerel, showing position of left testicle where lung and kidney meet.
(1) lung, (2) kidney, (3) testicle.

a special hook with a small knob at the end is used to raise the organ sufficiently so that the forceps may be manipulated around it for removal. If the upper testicle is removed first, any slight haemorrhage will obscure one's vision so the lower one cannot be readily seen.

The forceps or remover is now inserted through the incision held open by the spreaders, and the testis is secured between its jaws (Fig. 13). This is done by raising the organ slightly with the instrument closed, then allowing it to fall back and while so doing quickly opening the forceps and grasping the testis by manipulating the lower jaw under it before closing it again. With the locking type of forceps, care is necessary to draw the testis well away with the jaws slightly open, before locking the instrument. This taking up of the slack is advisable in any case. Otherwise the large vein (*posterior vena cava*) lying along the back above and between the two testes may also be caught in the instrument and be ruptured, resulting in the death of the bird. The forceps with enclosed testis are now gently withdrawn through the incision with a twisting motion until the various tissues connecting the organ to the body are severed (Fig. 14). The spreader is now removed, allowing the skin which had been pulled to one side to spring back and cover the opening and so prevent foreign material from entering (Fig. 15). The bird is now turned over without being unfastened and the remaining testis removed in a similar manner.

CAUTION

Care is necessary to make the incisions between the last and second last ribs (Fig. 16). If made one space forward the lung is likely to be injured

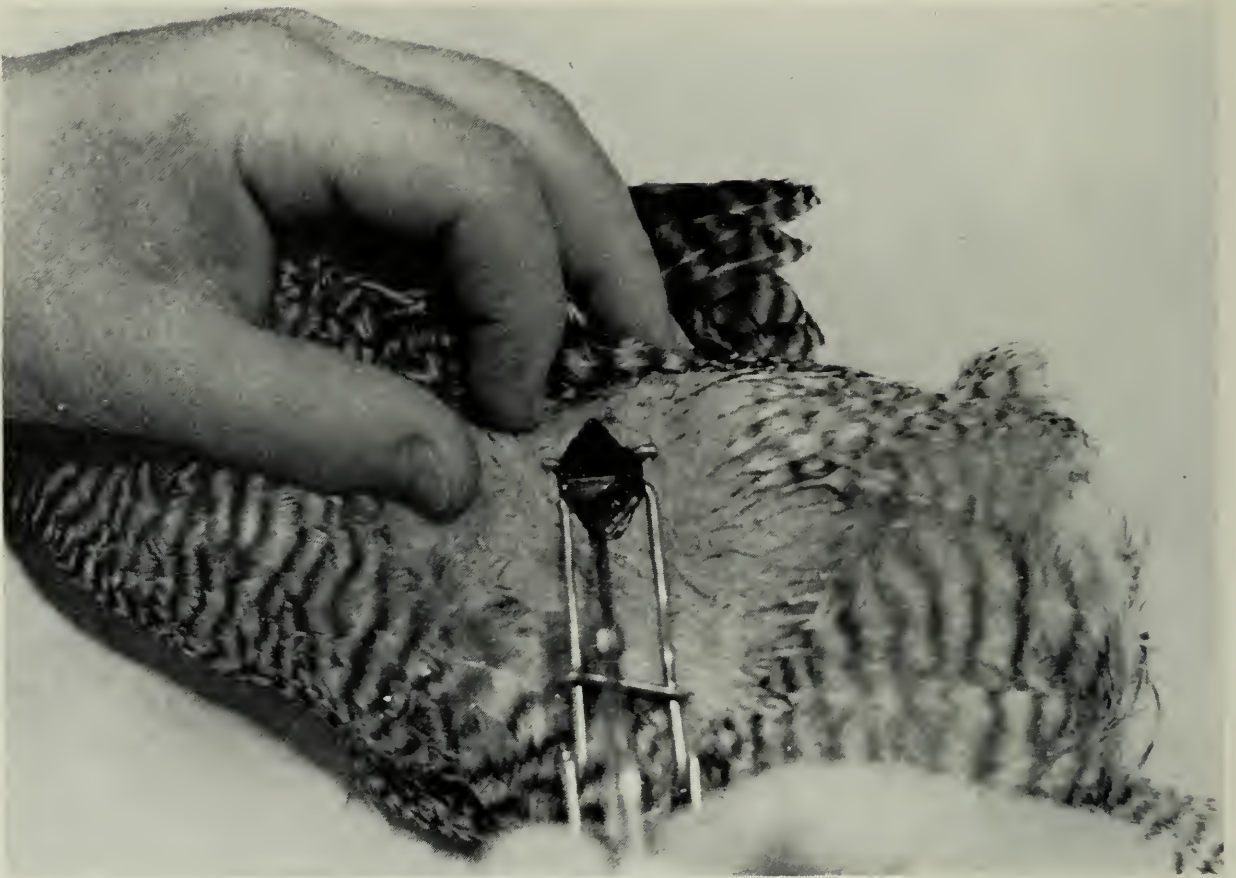


Fig. 13. Testicle in jaws of the forceps.

and, if behind the last rib, there is no rib to resist the spreader, making it necessary to hold the spreader in place with one hand while manipulating the forceps with the other. There is also danger of kidney injury and it is more difficult to locate the testes.

It is very important that not only every particle of both testicles be removed, but also the capsule or sac of peritoneal membrane surrounding each testis, including its attachments, the epididimus and a short piece of the *vas deferens* or cord. If this is not done, a high percentage of slips will usually result. To facilitate clean removal of all parts, the jaws of the remover must make perfect contact from corner to corner so that all tissue enclosed between them is removed. Locking the instrument helps the beginner to do this. With practice and experience, however, the average operator develops a sense of touch which enables him to exert just the right amount of pressure to remove all parts without necessitating the slight delay of each time locking and unlocking the jaws of the forceps.

The principal danger in caponizing is in accidentally rupturing one or more of the large blood vessels found in close proximity to the sex organs. The rupturing of certain of these results in such immediate and severe haemorrhage that death results in a few minutes. The rupture of certain smaller blood vessels may also result in profuse haemorrhage but from such injury practically all vigorous birds will quickly recover. If good light is available and care is taken to avoid including such blood vessels with the testes between the jaws of the forceps when removing them there will be little danger from the operation. The beginner will find a demonstra-



Fig. 14. The testicle withdrawn through the incision but still attached to cord (vas deferens) and peritoneal tissue.



Fig. 15. Two-week-old bird with operation completed and with the skin sprung back to cover the incision.

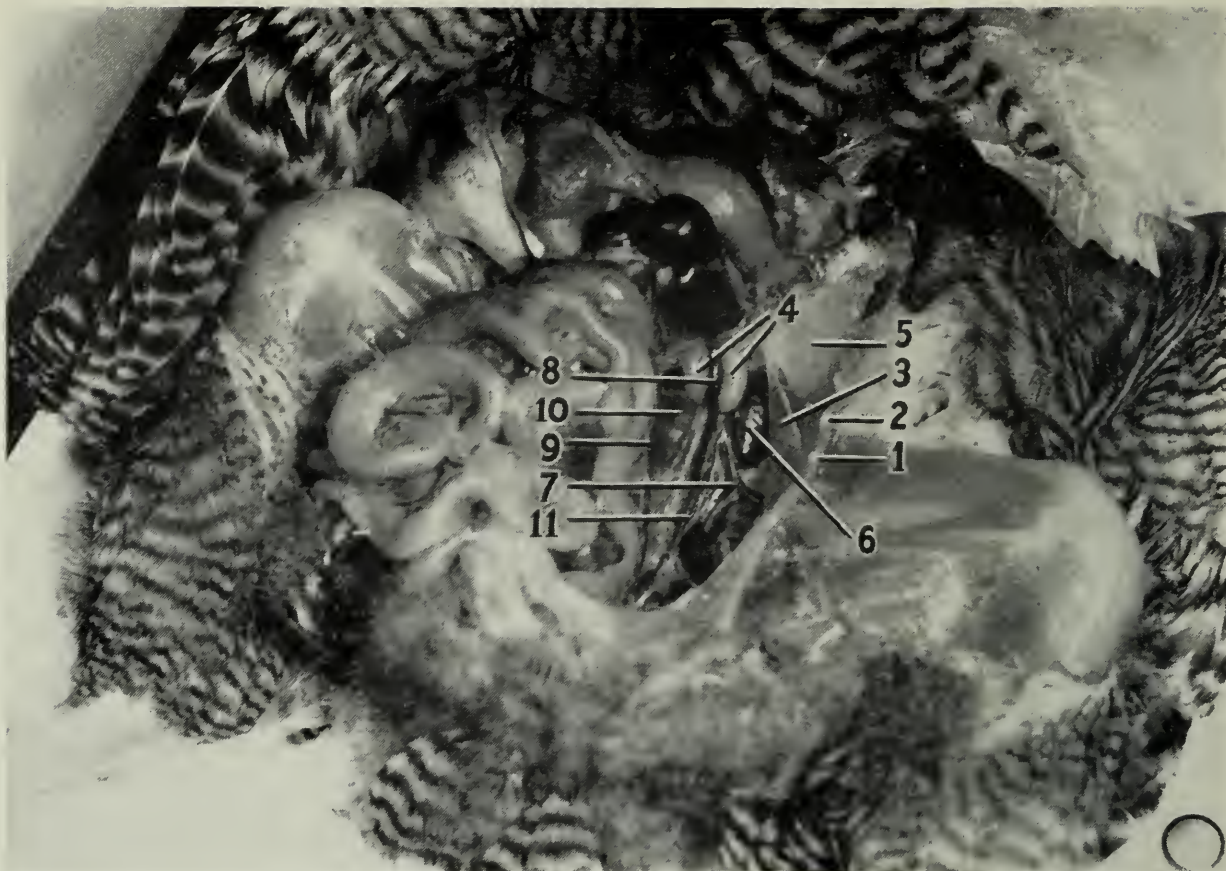


Fig. 16. Position of the testicles in relation to blood vessels and ribs. Last and second last ribs (1) and (2) between which incision is made. Walls of abdominal air sac (3) must be ruptured to reach testes (4), which lie posterior to the lungs (5) and anterior to the kidneys (6). The left (7) and right common iliacs unite to form the posterior vena cava (8). The coccygeo-mesenteric vein (9) and the mesenteric artery lying in close proximity to it in the region of the testes are sometimes ruptured when operating. A thin peritoneal membrane (10) separates the testes, the left one of which lies slightly posterior to the right one. Opposite the testes, the dorsal aorta (11) gives off a spermatic artery to each testis. Rupture of these may also be a source of haemorrhage.

tion by an experienced caponizer of great help. If this is not possible, confidence regarding technique may be developed by operating first on a dead bird.

OPERATING WITH THE ALL-IN-ONE INSTRUMENT

A number of Ontario operators regularly use the All-in-One instrument illustrated in Fig. 17. Made of a strong, but light-weight aluminum alloy, this instrument is so shaped as to afford good vision and is very convenient in use as all steps in the operation are carried out with one instrument. Several operators have reported sustained speeds with this type of instrument up to 200 and even more birds per hour and with relatively few slips. Figures 18, 19, 20 and 21 illustrate the method of use.

As with most sets of caponizing instruments, directions for use are supplied with the purchase.

OPERATING FROM ONE OR BOTH SIDES

Regardless of the style of instruments used, it will generally be found easier and more satisfactory to operate from both sides than from one side only. This is particularly true for the beginner. Usually fewer slips will result, recovery from the effects of the operation is just as rapid and little if any more time is required.

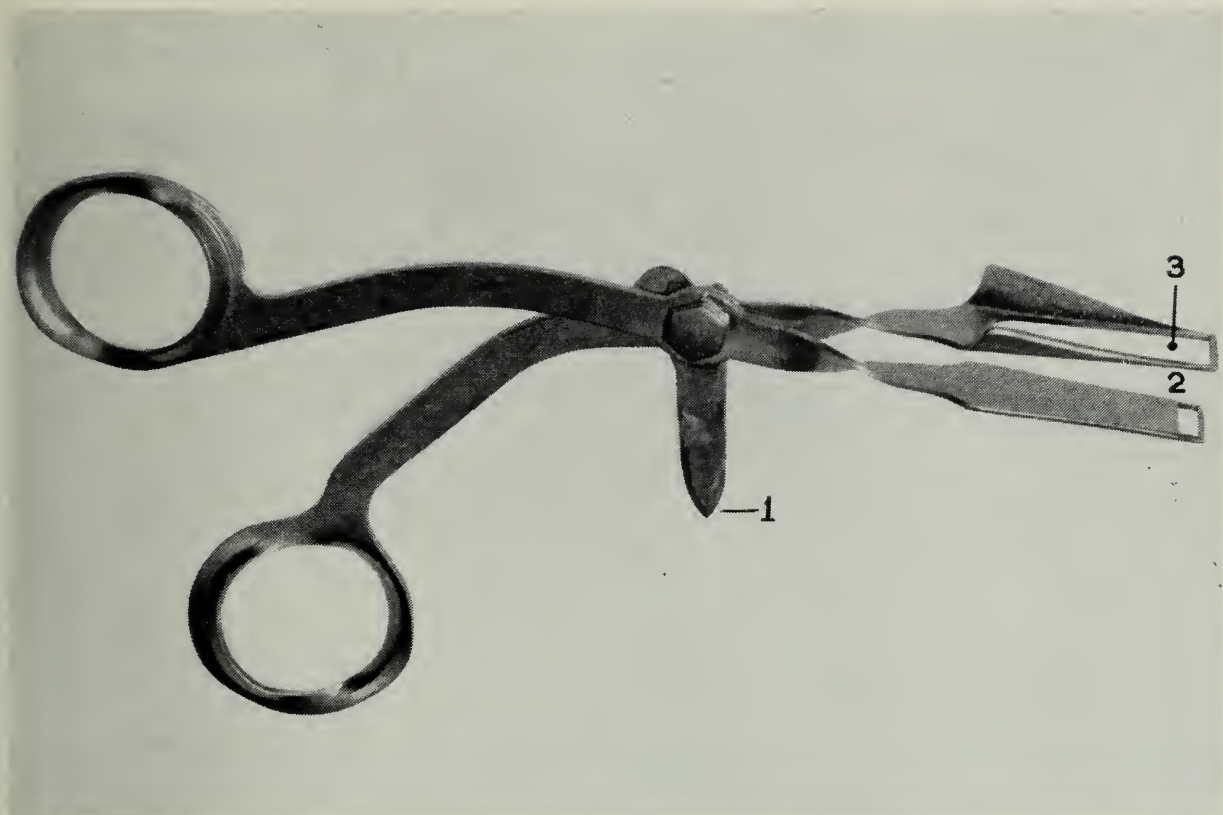


Fig. 17. All-in-one caponizing instrument. (1) scalpel, (2) spreader and forceps. Upper jaw has opening for good vision (3).



Fig. 18. All-in-one instrument in correct position for making the incision.



Fig. 19. All-in-one instrument inserted into incision ready for spreading.

CARE AFTER CAPONIZING

Following the operation the capons should be placed *by themselves* in a *clean, comfortably warm* pen or battery and given cool water to drink and a light feed of mash or crumbles. After a few hours time, feeding may be carried on as usual.

Care must be taken to avoid chilling or over-heating until the birds have recovered, or heavy losses may occur. *Also every effort should be made to avoid exposure to respiratory diseases or coccidiosis at this time.* Once they are healed and wind puffs have stopped developing, capons are just as rugged and easy to rear as corresponding cockerels.

WIND PUFFS

Following the operation and for from about two to three weeks thereafter some trouble will probably be experienced with wind puffs. These result from the unavoidable puncture of one or both abdominal air sacs during the operation. In exhaling, air is forced into the body cavity through these punctures in the air-sacs and out through the incision between the ribs. Because the skin over the incisions heals more quickly than the incisions between the ribs, air continues to be forced out and becomes trapped between the skin and body wall. As a result the bird rapidly becomes bloated (Fig. 22) and unless relieved becomes uncomfortable, awkward in getting about, may lose appetite and finally die. Puncturing the skin of such a bird with a sharp pointed knife will allow the trapped air to escape. One or more additional treatments may be required until bloating stops, which will occur when either the air-sac punctures or the incisions between the ribs heal over and prevent further build-up of air



Fig. 20. All-in-one instrument used as spreader.



Fig. 21. Testicle still attached to its membranes, but withdrawn from body through the incision, while held in forceps part of All-in-one instrument.



Fig. 22. A severely windpuffed capon.

pressure. Fortunately only the severely bloated birds require treatment, even though a considerable percentage may show some puffing. Few wind puffs continue after a week or ten days. Chilling of capons should be particularly avoided until all wind puffs have disappeared.

HOUSING, REARING AND MANAGEMENT

In the past most capons in Ontario were reared on range, late March to May hatched stock being used for the purpose. Such stock could be placed on range when 6 to 8 weeks of age and grown comparatively cheaply on growing mash, grain and pasture until from 24 to 26 weeks of age. Followed by 2 to 3 weeks of pen or crate fattening, such capons were in good finish for market. Growers preferring very high finish, held capons up to 7, 8 or even 9 months of age for a special market at Christmas, or even later, from January until Easter time. Most capons, however, were and still are sold directly off the range, preferably after being fattened by heavy feeding on grain. (Fig. 23.)

RANGE REARING

Range rearing requires good shelter — such as a colony house or range shelter — pasture, plenty of water and a ration of sufficient quality to induce fairly rapid and continuous growth.

Capons *should not* be grown in company with cockerels. Even slips that show much in the way of cockerel characteristics are best removed. Confinement at night will help to prevent loss from foxes, dogs, etc. Feed may consist of a good growing mash and grain, gradually increasing the



Fig. 23. Mature capons being fattened on range.

amount of the latter with age until the proportion is reached of $\frac{1}{3}$ mash to $\frac{2}{3}$ grain. Wheat and heavy oats make a good grain mixture. If pasture becomes meager or tough, more mash must be allowed. Periodic clipping helps to maintain fresh tender pasture.

CONFINEMENT REARING

Of late years some growers with more extensive operations have come to favour confinement rearing over range rearing. Ready-prepared feeds are now available which, when fed to good stock housed in comfortable, well-ventilated quarters, will readily produce 6 to $7\frac{1}{2}$ pound capons in from 18 to 20 weeks, and even larger birds in 21 to 23 weeks. Little special care will be required other than plenty of water and feed and ample feeding space. These growers have found that confinement-reared stock grows faster, tends to be more uniform and of better quality and suffers less mortality from predators than range-grown stock. However, respiratory diseases may prove more troublesome under confinement rearing, necessitating more attention to preventative measures. Such measures include allowance of ample floor space — 3 to 4 square feet per bird, adequate ventilation to prevent heavy accumulation of ammonia gas, and the *intelligent* use of antibiotics. Also, pens must be cleaned often enough to keep them reasonably clean, dry and comfortable.

The use of medicated feed plus good management will largely prevent coccidiosis, and any outbreak that may occur is usually of a mild nature and may be quickly overcome by immediate treatment with any up-to-date coccidiostat fed according to directions. Leucosis (big liver), can be minimized by the purchase of stock as free as possible from this disease and by avoiding contact of the chicks with older and particularly adult stock until 12 weeks or more of age.

BREAST CYSTS

Breast cysts are all too common in capons. Unless removed they seriously lower grade and in consequence sales value. Their number varies from flock to flock. Incidence of from very few to over 50% has been experienced. Rapidly grown, soft-muscle stock is more subject to this condition than slowly grown, more active stock. Also deep-breasted, slow-

feathering stock is more highly subject. Improper roosts, and wire or poorly bedded floors are additional causes. Capons tend to be rather inactive and, especially as they near maturity, sit about and/or roost much of the time. This may result in a high incidence of cysts and sometimes also in crooked breast-bones. The constant rubbing or irritation over the tip of the keel bone tends to develop a sort of bursa or sac — a breast cyst or “blister”. Well-managed, good type, healthy, fast-feathering stock, fed a ration balanced for steady growth and good bone development, should suffer little from such defects. Some breeds seem to be more subject to cysts than others but management and feed are the chief influencing factors.

ECONOMICS AND MARKETING

Success with capons, as is true of any phase of poultry production, is largely dependent upon the abilities of the individual grower. Much also depends upon the stock used, the mortality experienced, the cost of fuel, and the sales value of such poultry when marketed. A number of Ontario poultrymen and farmers have at times found the rearing of a flock of capons a profitable sideline. Some farmers with empty barn space have successfully raised capons indoors. Where this is done at least two crops can be produced in one year. However, range rearing is the more general practice. Confinement-reared stock marketed in the winter or early spring months is sometimes the more profitable. (Fig. 24C).

Following is shown the costs and returns from one such flock marketed in 1953. This farmer, as is sometimes true, was obliged to also purchase some pullets in order to secure the required cockerels. He was, however, able to sell the pullets when 14 weeks of age at \$1.25 each for laying purposes. He caponized the cockerels himself. Unfortunately separate feed accounts for pullets and cockerels were not kept.

PROFIT AND LOSS ACCOUNT OF CONFINEMENT-REARED FARM FLOCK OF CAPONS

EXPENSES	
December 2nd, 1952 — 1350 chicks (500 cockerels + 850 mixed)	\$ 210.58
6,200 lbs. Starter mash @ \$4.83 per cwt.	299.46
12,400 lbs. Broiler Starter @ \$4.42 per cwt.	548.08
11,600 lbs. Broiler Grower @ \$4.80 per cwt.	556.80
2,200 lbs. Corn @ \$3.74 per cwt.	82.28
200 lbs. Grit	2.70
500 lbs. Whey Concentrate @ 9¢ per lb.	45.00
Drugs and Cod Liver Oil	16.00
Heat and light	130.80
Insurance and equipment	10.00
Caponizing	45.00
	\$1,946.70

RETURNS	
March 14th, 1953 — 401 pullets @ \$1.25	501.25
March 24th, 1953 — 486 capons alive @ 43¢ per lb.	1,172.00
April 14th, 1953 — 370 capons alive @ 43¢ per lb.	965.40
	\$2,638.65

Labour Income for the 19 week period: \$2,638.65 — \$1,946.70 = \$691.95
 Straw was used for litter — well offset by the value of the droppings.
 Mortality was 6.88%.



Fig. 24. Capons may be successfully reared in small groups for family use, 24 a, or commercially either on range, 24 b, or in confinement, 24 c.

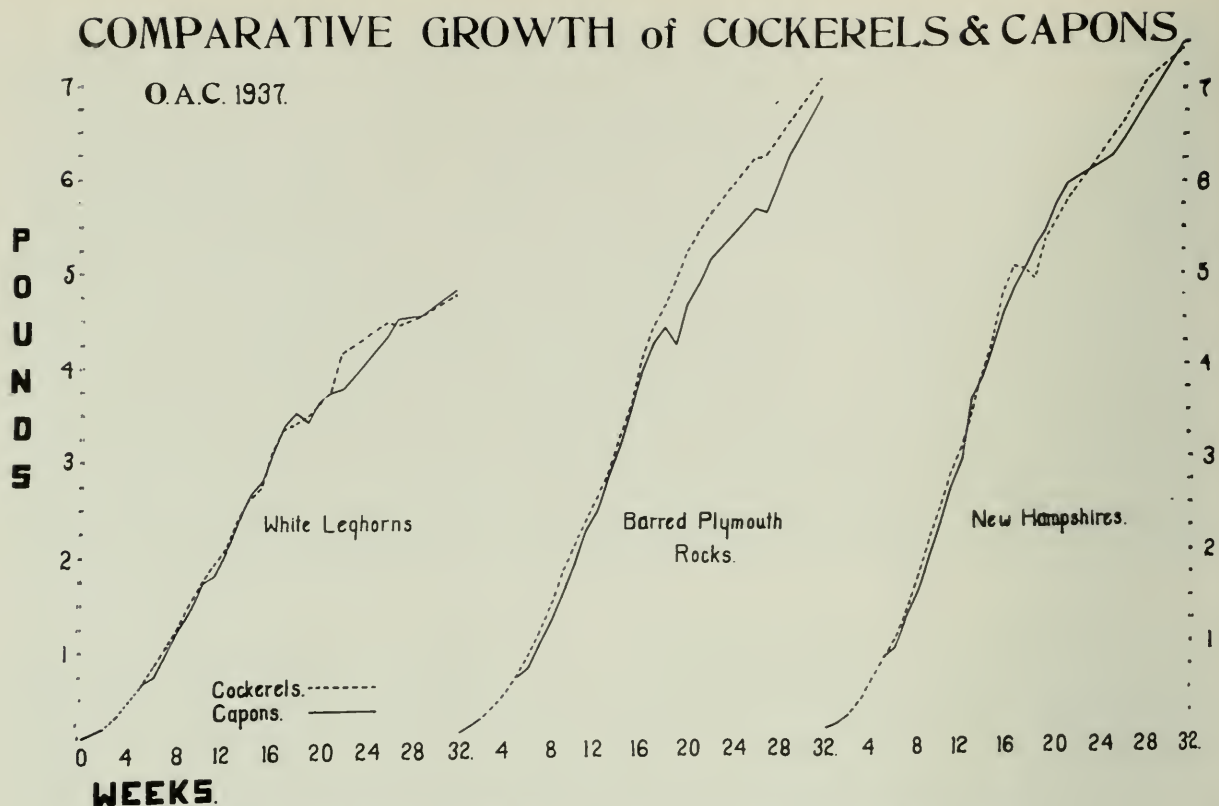


Fig. 25. Comparative growth curves of cockerels and capons of three breeds.

The foregoing capons were not carried to the usual size but were sold at a time when the price was favourable. Some consumers desire a 5- to 6-pound bird, but many prefer a capon of larger size. Time of marketing will therefore be conditioned by price and consumer preference.

There seems to be a somewhat general misconception concerning rate of growth and feed consumption of capons. Capons do not grow faster than cockerels and there is little advantage in feed consumption. Actually capons may require several weeks to recover from the slight setback following the operation. In Fig. 25 is shown the comparative growth rates of three breeds of capons and cockerels as found in an extensive experiment conducted at the Poultry Department, O.A.C. in 1937.

In Table No. 1, is shown the feed efficiency of triplicate groups of cockerels, capons and caponettes in an experiment conducted here in 1950 by Slinger and Pepper.

Table No. 1

FEED EFFICIENCY OF COCKERELS, CAPONS AND CAPONETTES

N.H. x B.R. AND B.R. COMBINED, BY THREE WEEK PERIODS, UP TO 21 WEEKS

(Pounds of Feed per Pound of Gain)

Period	No. at 21 weeks	0 - 3 weeks	0 - 6 weeks	0 - 9 weeks	0 - 12 weeks	0 - 15 weeks	0 - 18 weeks	0 - 21 weeks
Cockerels	131	2.326	2.99	3.026	3.526	3.376	3.91	3.93
Capons	151	2.086	2.77	2.80	3.06	3.106	3.106	3.77
Caponettes	135	2.326	2.916	2.83	3.406	3.256	3.81	3.88

The average weight of these groups at 21 weeks of age is shown in Table No. 2.

Table No. 2

AVERAGE WEIGHT OF COCKERELS, CAPONS AND CAPONETTES				
N.H. x B.R. AND B.R. AT 21 WEEKS OF AGE				
Kind	No. of Birds	N.H. x B.R. Weight in lbs.	No. of Birds	B.R. Weight in lbs.
Cockerels	85	6.08	46	5.72
Capons	99	5.89	52	5.48
Caponettes	85	6.19	50	5.49

In Table No. 3 is shown the grade of the carcasses of the 21-week-old stock after being dressed out and chilled, then graded according to Canadian standards for fleshing and finish except that conformation and dressing were not considered.

Table No. 3

PERCENTAGE GRADE OF N.Y. DRESSED GROUPS OF COCKERELS, CAPONS AND CAPONETTES										
AT 21 WEEKS OF AGE — GRADED FOR FLESHING AND FINISH										
Grade	Fleshing					Finish (fat)				
	S %	A %	B %	C %	D %	S %	A %	B %	C %	D %
Cockerels	40.45	32.82	21.37	5.34	0.0	34.35	40.53	20.61	4.58	0.0
Capons	46.00	30.00	24.00	0.0	0.0	72.00	22.00	4.66	1.33	0.0
Caponettes	62.68	18.65	16.41	1.49	0.74	71.64	19.40	7.46	1.49	0.0

It will be noted that the capons at this age were superior in finish to the cockerels and quite comparable to the caponettes. The fat on many of the caponettes graded "special" was excessive, while that on the corresponding capons was of sufficient amount only for the grade, therefore more economical. While the caponettes received a considerably higher grade for fleshing, this advantage was offset by a higher shrink when subjected to a cooking test.

In this test a random sample of ten carcasses of each group was taken and cooked, ten carcasses to a pan, in the same oven at the same time, the pans being rotated several times to avoid any variation in temperature because of position in the oven. The softness and excessiveness of finish in the caponettes resulted in a heavy shrink. The per cent of cooked weight taken of the eviscerated weight was as follows:

Cockerels	Capons	Caponettes
73.6%	75.0%	70.4%

This excessive shrink was further shown by the amount of dripings carefully weighed out of each pan. Calculated in per cent of the eviscerated carcasses this was as follows:

Cockerels	Capons	Caponettes
7.6%	5.8%	11.7%

In an earlier cooking experiment with capons in 1948 the percentage composition of 10 Grade A Barred Rock Capons averaging 7.3 lbs. N.Y. dressed, is given in Table No. 4.



Fig. 26. A rack of well-dressed 7 to 8 lb. capons of excellent conformation, fleshing and finish.

Table No. 4

**PERCENTAGE COMPOSITION OF 10 BARRED PLYMOUTH ROCK CAPONS
COOKED JULY 21, 1948**

No. of Birds	Bones %	Giblets %	White Meat %	Dark Meat %	Total Cooked Wgt. (lbs.)	% Edible of Cooked Wgt.
10	24.86	4.74	33.47	36.92	43.5	75.14

The percentage composition of the total edible portion of the ten capons was as follows: Giblets 6.30%, White Meat 44.55%, Dark Meat 49.14%. The per cent of cooked edible meat, giblets included, calculated on the N.Y. dressed weight and on the ready-to-cook weight was 44.39% and 53.86% respectively. These yields compared favourably with well finished turkeys cooked in the same revolving oven at the same time. The appearance, texture and flavour of the capon meat also compared favourably, being superior to the turkeys if anything, in these respects.

DRESSING PERCENTAGES

The dressed and eviscerated yields of capons vary with finish and maturity. In Table No. 5 is shown the data from a group of 219 well-finished 25-week-old meat type, White and Barred Rock capons. This stock was indoor-reared and the dressed weights are for "slush" chilled (ice and water), well-drained carcasses.



Fig. 27. Marketing ready-to-cook and cut-up capons at the Kitchener farmers' market.

Table No. 5

No. of Capons	Av. live weight	Av. dressed weight	Av. Evisc. weight	% Dressed weight of live wgt.	% evisc. weight of live wgt.	% evisc. weight of dressed wgt.
219	7.17 lbs.	6.57 lbs.	5.80 lbs.	91.63 %	80.89 %	88.28 %

MARKETS AND MARKETING

The demand for, and production of medium to large-size roasting chickens has undergone a marked decrease during recent years. This condition will likely continue, the reason being the tremendous increase in production and consumer acceptance of broiler and fryer-size chickens. This smaller stock has a higher feed efficiency, four crops can be produced per year and special feeds and objective breeding have resulted in a highly desirable product.

It is generally agreed however, that there will probably always remain a good market for a considerable number of high-quality roasting chickens. The family-size roasting chicken of from 5 to 7 pounds or larger, eviscerated weight, still has a definite place in many consumers' requirements. To successfully compete for this market such stock must be rapidly and cheaply grown and have good but not excessive finish. Such stock must also be ready for market at an earlier age than formerly to make possible the improved feed efficiency necessary for economical production.

Capons, because of their quieter disposition, ease of handling and greater tendency to finish well in comparison with cockerels, fit well into this picture. Their flesh is fine textured, the flavour more mature than



Fig. 28. An Ontario capon grower, vacuum packing capons in plastic bags ready for freezing.

that of fryers and the quality of meat is unsurpassed (Fig. 26). Because of this a market for capons can generally be readily built up in any town or city and usually at a premium price over that commanded by cockerels (Fig. 27). The much increased use of household freezers has also opened up a fine market for roasting chickens. A half dozen or dozen cleanly dressed, ready-to-cook, plastic packaged capons (Fig. 28), makes a most desirable addition to the contents of any home freezer or locker.



THE PACKING HOUSE

ON THE

FRUIT FARM

CA20NAF6
B511



A FRUIT PACKING HOUSE, ATTRACTIVE OUTSIDE AND WELL-ORGANIZED INSIDE.

ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

INTRODUCTION	3
SITE	3
EFFICIENCY IN THE PACKING HOUSE	3
Planning the Packing House	4
Floor Area	4
Accessibility	5
Storage Space for Empty Containers	5
Ceiling Heights	5
Efficient Use of the Building	6
Packing House Plans for the Small Fruit Farm	6
Packing House Plans for Medium Size Fruit Farm	8
Packing House Plans for the Large Fruit Farm	8
Equipping the Packing House	9
<i>In-Plant Transportation</i>	9
<i>Grading Equipment</i>	9
<i>Other Packing House Equipment</i>	12
Converting Older Buildings to Packing Houses	14
SERVICES TO THE BUILDING	15
Lighting	15
Water Supply	16
Toilets	16
Fire Protection	17
Heating	17
Disposal of Waste	17
Clock	17
Fly Control	17
First Aid	17
Insurance	17
OFF-SEASON USES	18
FRUIT HANDLING EQUIPMENT	18
Tractor and Trailer	19
Tractor-mounted Lift and Pallets	20
Hand-lift Truck and Pallets	21
ACKNOWLEDGMENTS	21

THE PACKING HOUSE ON THE FRUIT FARM

W. H. UPSHALL, *Horticultural Experiment Station, Vineland*

J. M. FITZPATRICK, *Economics Division, Canada Department of Agriculture,
Ottawa*

J. POS, *Department of Agricultural Engineering, O.A.C., Guelph*

Ontario fruit encounters keen competition from the products of other areas of Canada and of other countries. It is therefore necessary to grow good fruit and to package it in suitable containers. The packaging operation is usually done in a building constructed or adapted for the purpose.

This publication is designed to point out the desirable features of a packing house and its equipment to the end that the packing will be done in an efficient manner. The aim should be a pack well above the minimum requirements of the grade yet within reasonable limits of cost. The maximum use of labour-saving devices and an arrangement of facilities to conserve the energies of the packers for the actual packing operations should be kept constantly in mind.

The subject is being considered herein on the basis of individual-grower operation, not group or co-operative. However, many of the principles will apply equally well to a community packing house. Cold storage rooms will be considered only with respect to their position relative to the packing area.

SITE

Theoretically, the packing house should be situated in the centre of the orchard area. However, other considerations may make this inadvisable. First of all, a well-drained area is very important, permitting access by truck at any time during the year. Where natural drainage is questionable, tile under-drainage is recommended. If sufficient space is available, a roadway, preferably hard-surface, circling the building lends itself to speedy unloading and loading and to dust-free conditions. In any case, trucks should not be cramped for turning space. The availability of electricity and water may determine to a large extent the location of the building but the grower should compare carefully the costs of building and operation in various locations.

EFFICIENCY IN THE PACKING HOUSE

Once picked, fruit must be sorted, graded, packed in suitable containers and then shipped to market. The net income received from the fruit enterprise depends, to a considerable extent, on packing efficiency. The notable progress made in the mechanization of pre-harvesting operations has led to a reduction in the labour costs of these operations but little has been done to reduce packing house labour costs.

In 1954 a survey* of 40 peach packing houses on Ontario farms was conducted as a joint project of the Ontario Farm Economics Branch and the Economics Division of the Canada Department of Agriculture.

Sketches were made of the floor plans of these packing houses showing location of doors and windows, the arrangement of the grading and packing equipment and the movement of the fruit through the packing house. Data on

*The complete report, entitled "Peach Handling Methods and Equipment in Ontario", is being published by the Ontario Farm Economics Branch, Parliament Buildings, Toronto.

each type of operation were secured along with detailed time-and-motion studies of these operations. These studies provide a reliable basis for the design of more efficient layouts and work methods.

A packing house may be used for efficient handling of stone fruits as well as apples and pears. The following discussion relates to the handling of fruit during the peach season, but the plans of farm packing houses were designed for the handling of various kinds of fruit. The peach enterprise was given special consideration because its success depends largely on the ability of the workers to handle well-matured fruit without seriously bruising too large a part of the crop. Although other fruit may not require the same degree of handling care, this prerequisite must be taken into account in the design of efficient packing houses.

Planning the Packing House

The size and type of packing house, and the specific facilities provided, depend principally on the amount of capital available and on the tonnage of fruit produced. The packing house must have convenient working space, adequate lighting, and enough equipment for quick handling of the fruit. The first two of these points concern the design of the packing house itself, and may be discussed under the following headings: floor area, accessibility, storage space for empty containers, and ceiling height. Discussion of these topics will take the form of an analysis of data collected during the survey.

Floor Area

The packing houses had an average floor area of 1,566 square feet including 1,438 square feet for the handling of fruit and 128 square feet for other purposes. The fruit-handling area was divided as follows: receiving area 491 square feet; packing area 235; lenoing or lidding area 95; shipping area 548; and ground-floor basket-storage 69. Details on the division of the floor space between these five areas, according to the size of the total floor area are presented in Table 1. Floor area averaged 714 square feet on farms where an average of 56 tons of fruit were handled; 1,106 on those where 107 tons were handled; and 2,419 on farms averaging 167 tons. Packing area on smaller enterprises were usually in buildings designed and built specifically for a purpose other than fruit handling. By taking into account the limitations of these buildings in the analysis of the survey data, in general, one square foot of floor space is required for each 150 pounds of the major fruit marketed. A farmer, therefore, marketing approximately 125 tons of his major fruit annually should have a packing house with about 1,700 square feet of floor space. If the other fruits are picked during the packing season of the major fruit, for purposes of determining floor space required, this tonnage should be added to that of the major fruit.

TABLE I — Average Floor Area Available in Packing Houses, 1954 Survey

	Packing House Area (sq. ft.)			Average, all Groups
	Less than 900	900 to 1,299	1,300 and over	
Shipping area	226	419	967	548
Receiving area	230	339	376	491
Packing area	177	189	330	235
Lenoing or Lidding area	61	79	142	95
Basket storage, main floor	20	80	104	695
Total fruit-handling area	714	1,106	2,419	1,438
Floor area used for other purposes	*42	302	230	128
Total packing house floor area	756	1,408	2,649	1,566

*Other purposes include year-round storage of machinery and field supplies.



FIG. 1. Overhead basket storage on an Ontario fruit farm. Storage space must be clean and well organized to minimize the risk of fire.

Accessibility

The floor area of packing houses should be readily accessible and of convenient shape. At least two sides of the packing area should be so designed as to permit easy access for trucks and tractors. Fruit can be received and loaded out most rapidly when packing house floors and loading docks are at truck and orchard trailer heights.

Storage Space for Empty Containers

In 35 of the 40 packing houses, the empty packages were placed in a storey above the packing area (Fig. 1). When needed, they usually had to be moved by hand to the first floor. Only one packing house had chutes (Fig. 2). These chutes made it possible to save time and effort in supplying empties to the packers, and to reserve all of the packing floor area for its fruit handling purposes. The survey data indicate that, on the average, 485 square feet of floor space, either above the packing area or in another building, was used for storage purposes in addition to the 69 square feet of packing floor area. What remains to be done then, on many fruit farms, is to install a chute or some other apparatus for the quick and easy transfer of containers from the storage to the packing area.

Ceiling Heights

In general, ceilings should be nine feet high except in cases where trucks are to be driven into the building. The height should then be increased to 13 feet or more, depending on the type of vehicle used and the height of the loaded truck.



FIG. 2. Basket chutes from overhead storage. The packers lose no time in getting baskets.

Efficient Use of the Building

The packing houses surveyed were used, on the average, 55 days per year for the handling of fruit. During the remainder of the year, the building was used mainly for storage of machinery, equipment, and baskets. This short period of use stresses the need for economical, flexible, and functional structures. The Agricultural Engineering Department of the Ontario Agricultural College has prepared working drawings of packing houses for the small, medium, and large fruit farm.

Plans for the small, medium, and large packing houses, and for the hand-lift truck (Page 12), are included in the Fruit and Vegetable Storage and Equipment Catalogue of the Canadian Farm Buildings Planning Service. This catalogue may be obtained from your Agricultural Representative.

Packing House Plans for the Small Fruit Farm

Packing houses for farms handling between 75 and 125 tons of the major fruit or less each season should have between 1,000 and 1,700 square feet of floor space as well as some space other than the main packing house floor for storing containers. A suggested plan for this type of building is given in Figures 3 and 4. One of the farms surveyed used a low-cost pole structure (Figure 5). Although a cement floor, fluorescent lighting and better protection against the elements are usually recommended, it may be said that the basic design of this building is very practical for the farmer who wants an efficient low-cost structure.

Data on efficient crew sizes and labour requirements during the peach season for the small packing house are given in Table 2. On farms where all fruit is packed in six-quart baskets, six workers will handle about 1,000

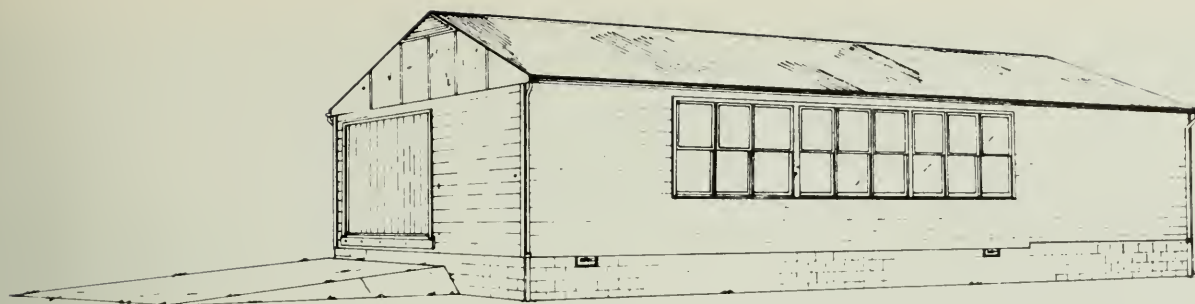


FIG. 3. Packing house for the small fruit farm.

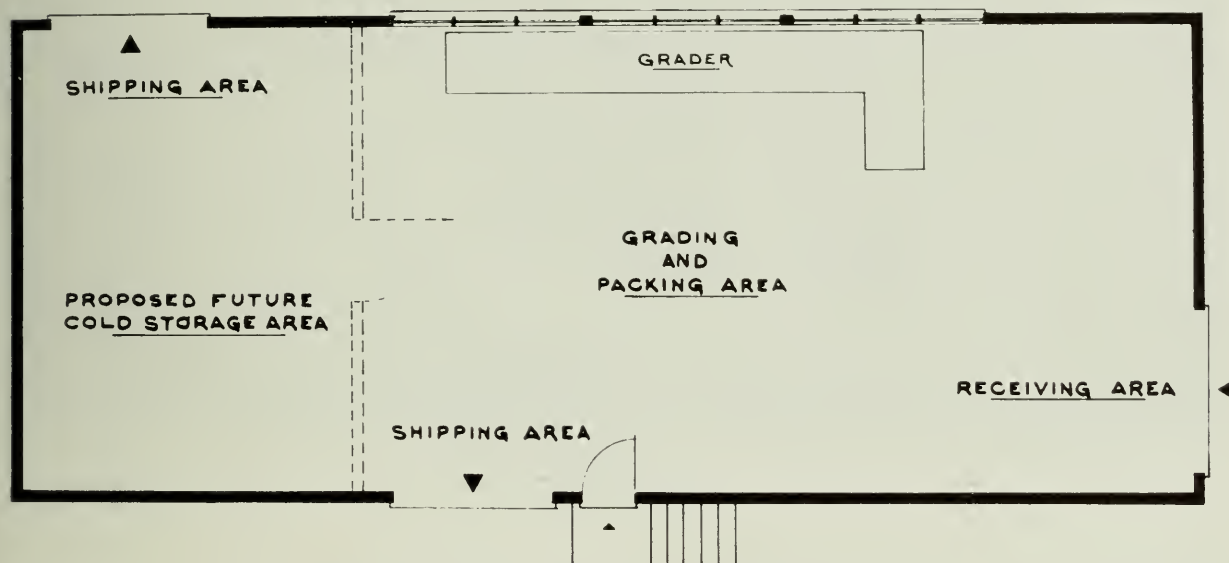


FIG. 4. Packing house layout for the small fruit farm.

pounds (100 heaped six-quart baskets) per hour. When one-half of the fruit is picked off the elevator for the factory trade, a crew of seven can efficiently handle 1,600 pounds per hour.

Crew sizes were determined from time-and-motion studies of each operation in packing houses. Productive labour standards per 1,000 pounds of peaches handled were as follows: unloading, 4.7 minutes; dumping, 12.8; sorting, 21.3; factory-box packing, 55.4; six-quart basket packing, 192; and lenoing, 46.4. Fatigue allowance ranged from ten to twenty per cent of the productive labour required, depending on the type of operation.

TABLE 2 — Efficient Peach Packing Crews for Small, Medium and Large Packing Houses

PACKING HOUSE SIZE		
Small (a)	Medium (b)	Large (c)
1 dumper and sorter	1 dumper and sorter	1 dumper
4 six-quart basket packers	6 six-quart basket packers	1 sorter
1 lenoer	1 lenoer (full time)	9 six-quart basket packers
6 workers	1 lenoer and foreman	2 lenoers
	9 workers	1 foreman
		14 workers

(a) Six workers can handle one-half ton of peaches per hour.

(b) Nine workers can pack three-quarters of a ton of peaches per hour.

(c) Fourteen workers can handle one ton of peaches per hour.



FIG. 5. A low-cost pole packing shed.

Packing House Plans for Medium Size Fruit Farm

With from 125 to 200 tons of the major fruit handled annually, it is recommended that packing houses should have between 1,700 and 2,700 square feet of floor space. The actual size will depend on the maximum volume of fruit a farmer intends to package. An efficient packing house, under average conditions, is illustrated in Figures 6 and 7. A cold storage room is included in this plan. Although the initial cost of cold storage space is higher per cubic foot than packing area, good returns can be expected if money is invested wisely.

Data on labour requirements for medium size packing houses during the peach season are also presented in Table 2. Nine workers can basket 1,500 pounds of peaches per hour or select 1,000 pounds from the elevator for the factory trade plus about 1,000 pounds for the basket trade each hour.

Packing House Plans for the Large Fruit Farm

When over 200 tons of the major fruit are to be handled annually, it is wise to build a packing house with from 2,700 to 3,300 square feet of floor space for the packing operations and an additional 1,200 square feet for cold storage. A plan similar to that shown in Figures 8 and 9 will operate efficiently.

On large fruit farms, efficient packing operations during the peach season will require 14 workers who can basket one ton of peaches per hour. For efficient fruit handling, two extra crew members should help pick off the elevator at times when peaches are to be sent to the factory. Almost one and three-quarter tons of peaches can be handled each hour in this manner.

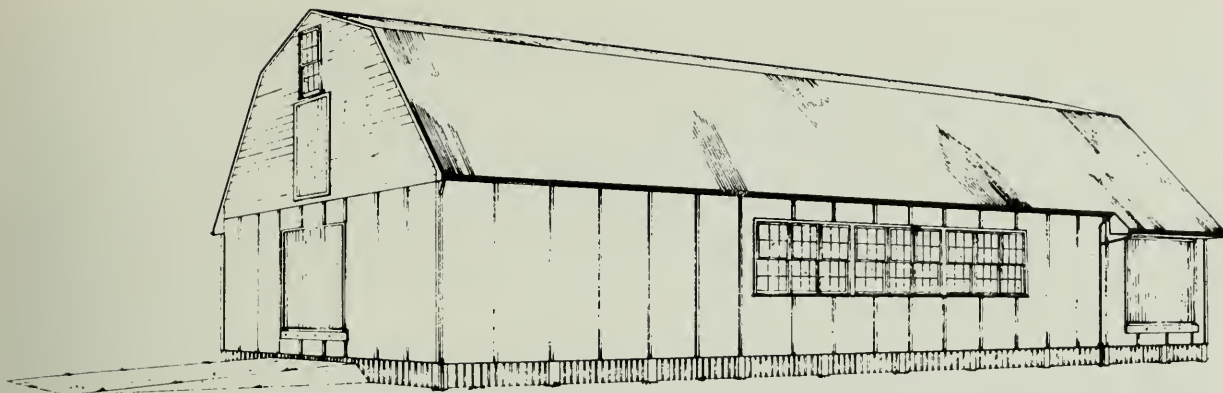


FIG. 6. Packing house for the medium size fruit farm.

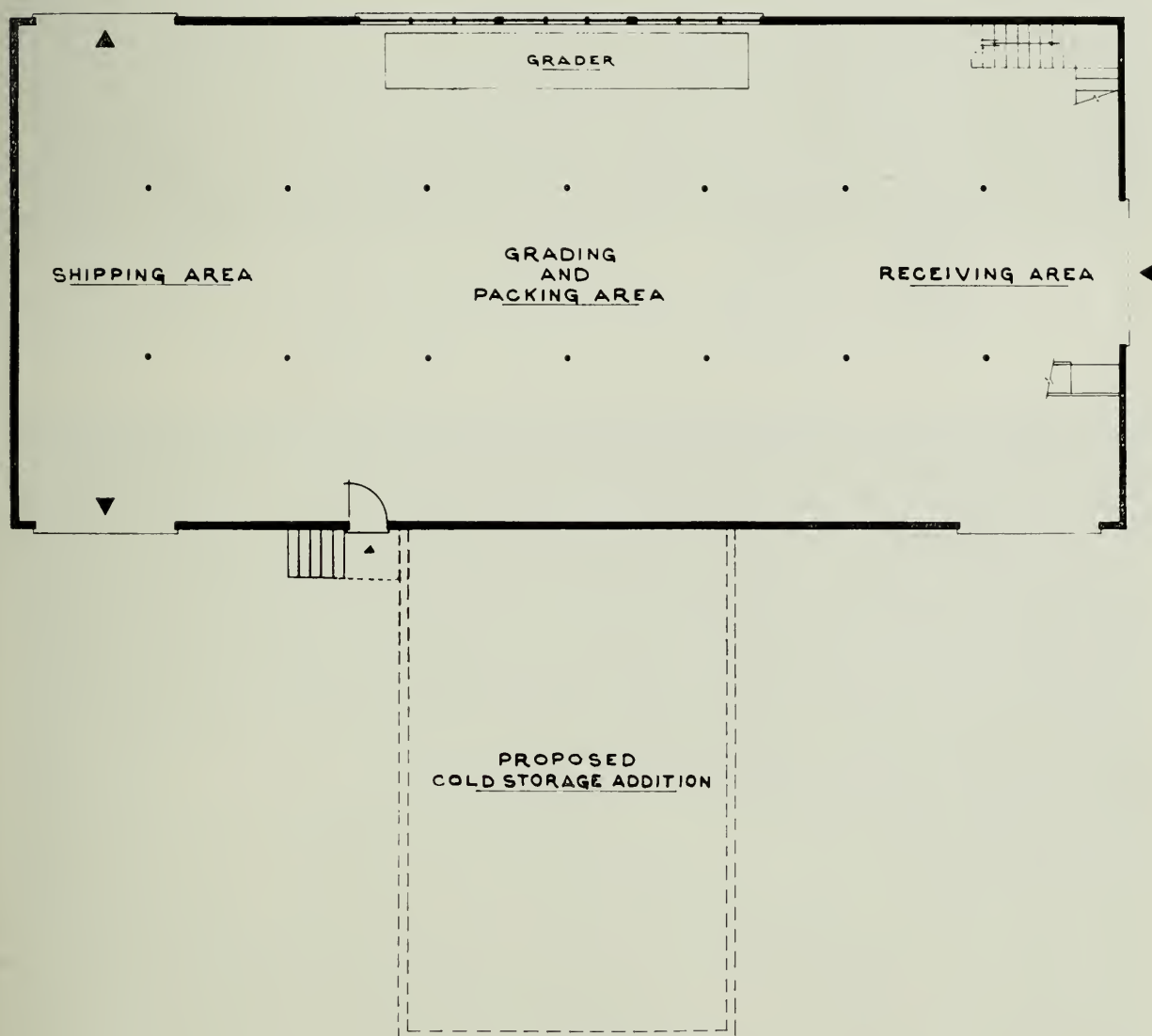


FIG. 7. Packing house layout for the medium size fruit farm.

Equipping the Packing House

In-Plant Transportation — Labour costs are much too high to permit workers to carry only two or three baskets of fruit at a time from one place to another. The total physical exertion required to lift and transport tons of material daily in this manner is an important factor in reducing working efficiency. In order to save time and eliminate much heavy labour in handling fruit, roller conveyors (Figure 10), hand trucks (Figure 11), or pallets and pallet trucks (Figure 12) can be used. Time-and-motion studies revealed that the pallet and pallet-truck method was most efficient, requiring only one-seventh of hand-unloading time.

Grading Equipment — The type of equipment used for elevating and grading will depend to a large extent on what types of fruit are to be handled (Figures 13 and 14). One of the most widely used types of grading equipment is the diverging belt sizer and it is among the most simple and best of the graders. It is low priced, compact, and efficient. The one limitation is its inaccuracy when fed indiscriminately with fruit which is not spherical.

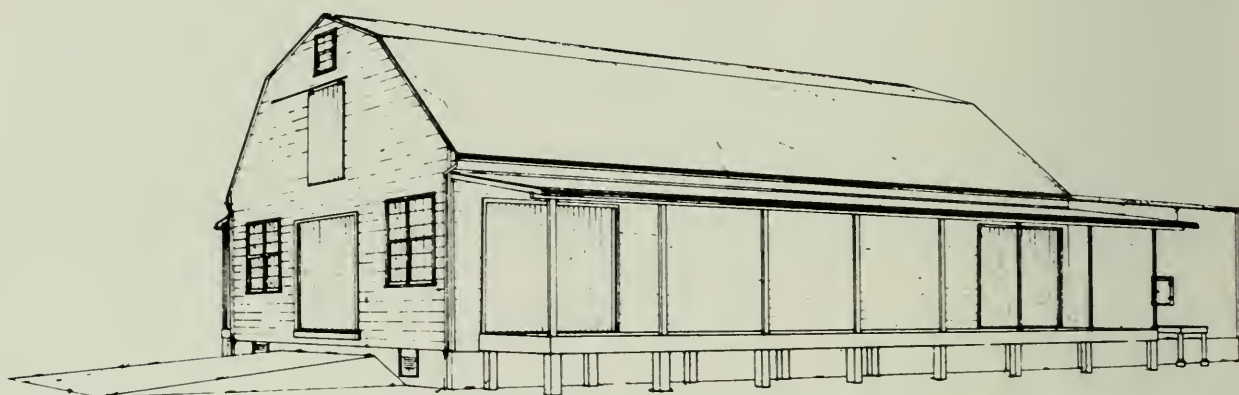


FIG. 8. Packing house for the large fruit farm.

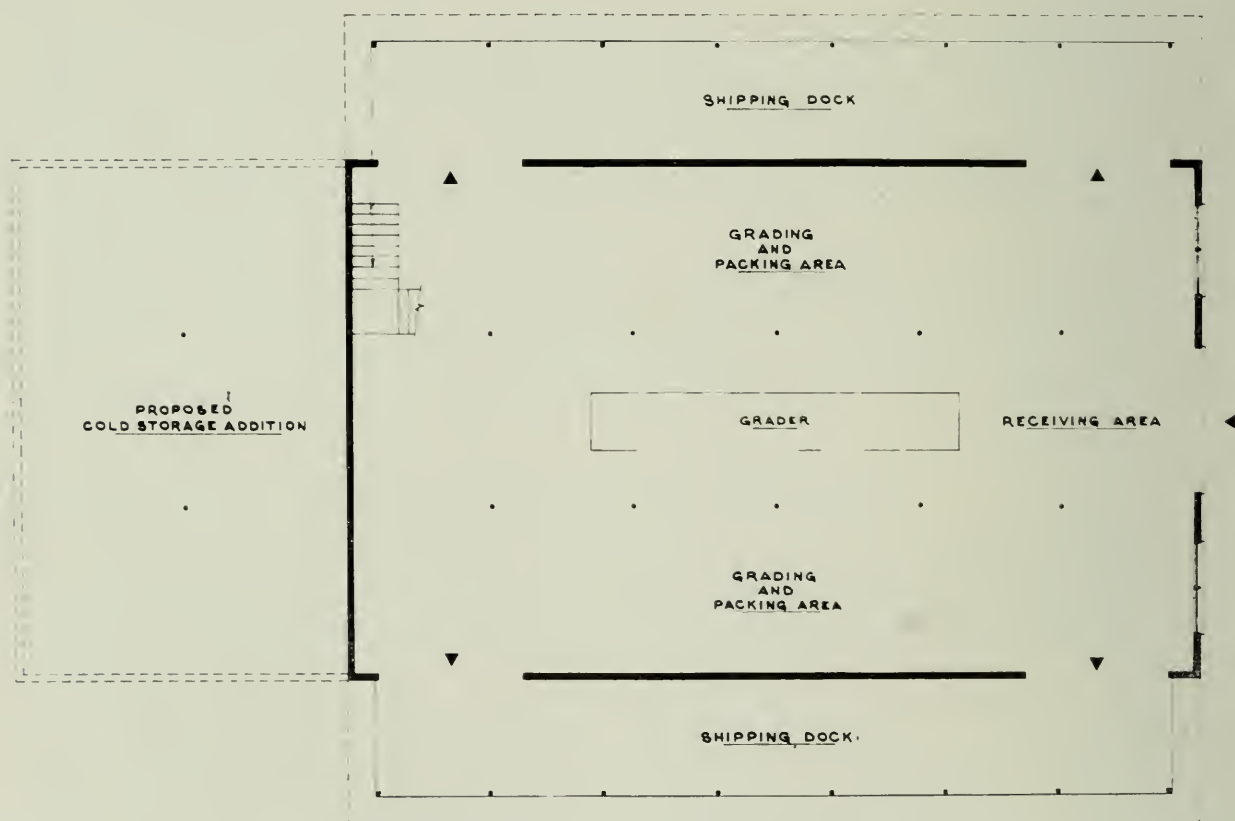


FIG. 9. Packing house layout for the large fruit farm.



FIG. 10. Peaches being transferred from trailer to grader on a roller conveyor. Ball-bearing aluminum rollers 1.9 inches in diameter, 14 inches in length, spaced at $2\frac{1}{4}$ -inch centres are recommended for peaches. The sections come in 5- and 10-foot lengths.



FIG. 11. One type of hand truck. Large centre wheels would permit easier handling.



FIG. 12. Hand-lift pallet truck for in-plant transportation.

Fruit is either dumped onto a roller-type elevator or directly into a feeder tray. In either case the excessively bruised and cull fruit (and at times factory supply) is removed, leaving the remainder of the fruit to pass through to the sizing belts. Sizing takes place between a pair of belts which act both as conveyors and sizers. The belts slide along two angle iron supports which are close together at the point of entrance and farther apart at the exit. As the belts move forward, their distance apart increases and eventually the fruit supported on them falls through into receiving trays.

The position of this equipment should be similar to that shown in the floor plans for the small, medium, and large size packing house. An alternative position for the grader in small packing houses is possible where fluorescent lighting is available. By placing the grader lengthwise across the packing house floor, approximately fifteen feet from the receiving end, the receiving and dumping areas will be divided, allowing the fruit to travel in one direction through the packing house to the loading platform.

Other Packing House Equipment — Lidding table, knives, ladders, hammers and comfort equipment such as standing mats and oscillating fans are small items but mean much in the efficient handling of fruit. In 25 per cent of the packing houses studied, packing operations were slowed down considerably because of faulty equipment. Makeshift linoing knives, shaky tables and broken ladders were used while other crew members stood around until called to work again. A large portion of this delay can be eliminated by making it someone's duty to see that all equipment is ready for use every morning. This will do much to ensure co-operation from packing house workers.



FIG. 13. The diverging-belt type of peach grader. It divides the peaches reasonably well into size categories if properly adjusted for various shapes and sizes of fruit.

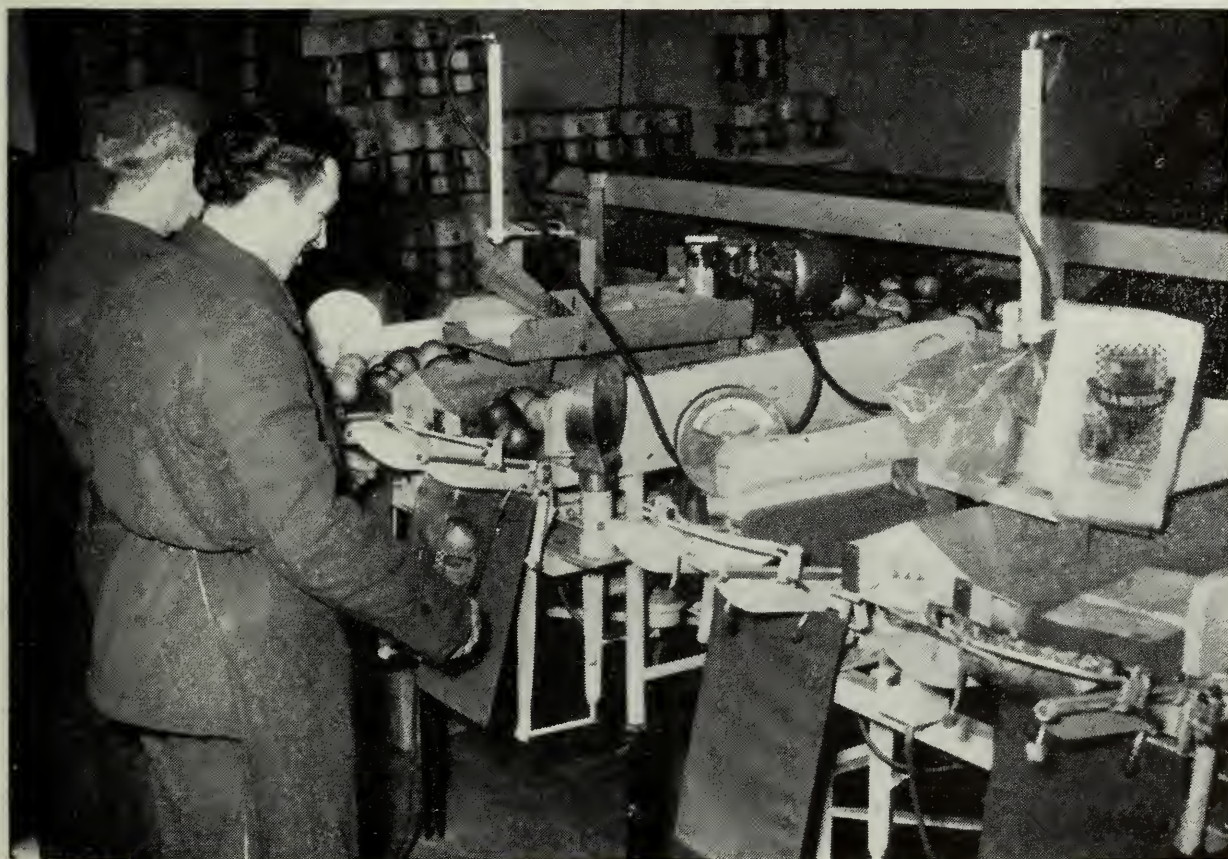


FIG. 14. Grading and bagging apples. Note scales used in assuring proper weight of fruit.



FIG. 15. Barn converted for fruit packing.

Converting Older Buildings to Packing Houses

On many Ontario fruit farms, there are buildings still in excellent condition but no longer needed for the purpose for which they were designed. At least some of these buildings can be converted to efficient packing houses by following the recommendations for new buildings (Figure 15).

In converting older buildings, as in building new structures, it is necessary to calculate the maximum amount of fruit that will be packed. If less than 125 tons of the major fruit are to be handled, 1,000 to 1,700 square feet of accessible floor space should be used. If between 125 and 200 tons are packed, 1,700 to 2,700 square feet of floor space will be required. Larger packing houses, where over 200 tons of fruit are handled, will need from 2,700 to 3,300 square feet of floor space for the handling operations as well as 1,200 additional square feet of cold storage space.

On making arrangements for the construction of a suitable all-weather drive leading to two or more sides of the building, actual building renovation can be started. It is best to begin by removing all obstructions except the necessary uprights. Floors can then be repaired for uniform height and smoothness. Greater fruit-handling efficiency is achieved when floors are elevated to orchard-trailer height. This may not be possible because of ceiling height. In any event, a poured concrete floor is satisfactory.

Packing houses require conveniently located doors of adequate size. Overhead ten-foot wide doors were most satisfactory in the packing houses studied. However, sliding doors give reasonable satisfaction.

Elevating and grading equipment can be laid out in various ways, depending on the shape of the floor area. In general, the layout, as shown in Figures 4, 7 and 9 may be used to good advantage. When deciding on equipment location, artificial lighting can be installed to ensure good illumination at all times.

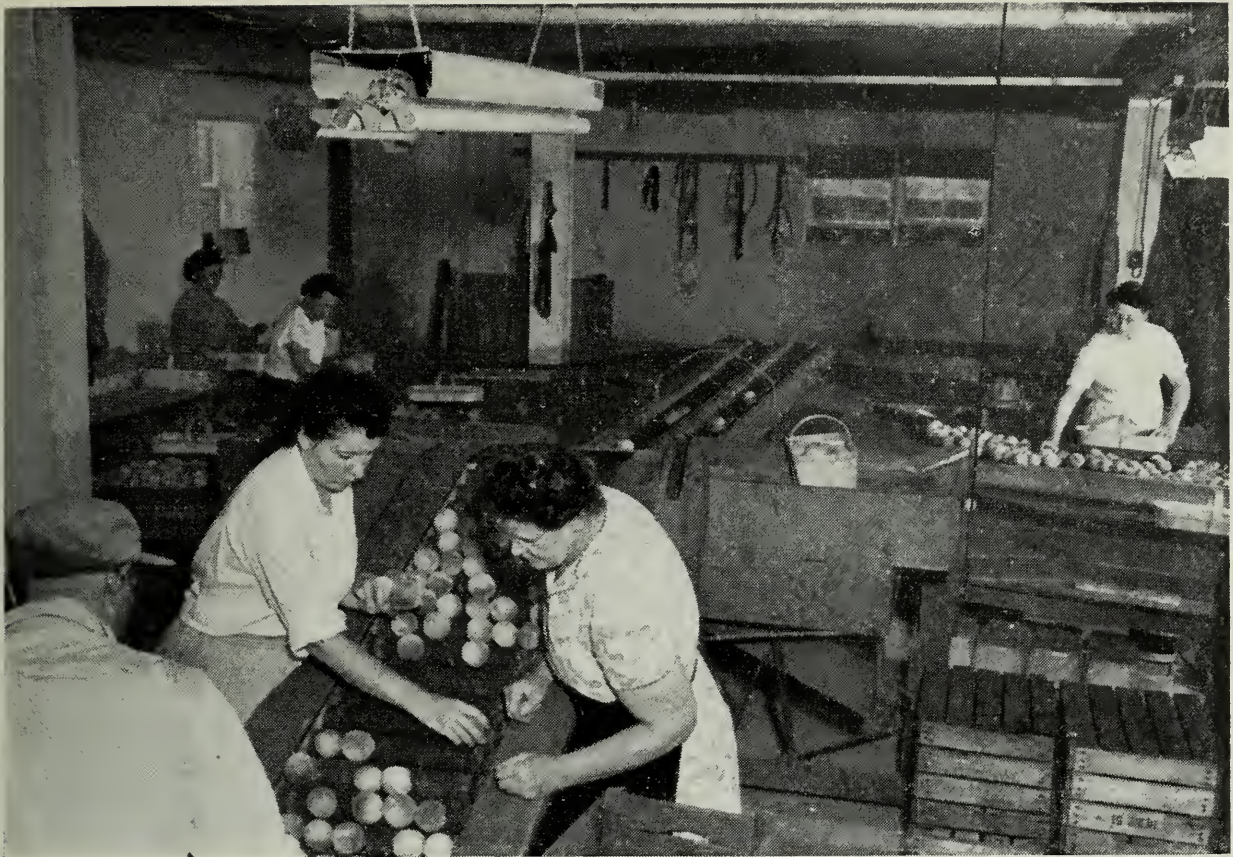


FIG. 16. Good lighting is especially important over the sorting conveyor or table.

In many older buildings much delay is caused during packing operations through obsolete methods of handling containers. As with new structures the use of conveyors, chutes, and hand trucks can speed up the work considerably.

Renovations in older buildings present problems too numerous to describe in a general bulletin on packing houses. A good rule for those who are contemplating making a change is to make a detailed study of new building designs and try to duplicate as closely as possible, the plans which are most efficient for that particular size of fruit enterprise.

SERVICES TO THE BUILDING

Lighting

It is suggested that the window area be equivalent to 15 per cent of the floor area. The windows should be double hung or inside-opening casement type, the former preferred because insertable rain-excluding wind screens can be used. They facilitate cooling of the building at night.

Even with abundant window area there will be times when supplemental lighting will be needed for best results in sorting the fruit. Because of low-heat transmission with relation to light amount, fluorescent lighting is preferred to incandescent even though the initial cost is higher (Figures 16, 17).

Only fluorescent lighting assimilates daylight conditions. With the proper selection of bulbs, fruit ground colours appear as they do outside and defects, such as rot spots, are easy to detect even on a red cheek. The Ontario Hydro Electric Commission recommends two-lamp industrial fluorescent fixtures with louvers, suspended $7\frac{1}{2}$ feet above the floor. The lamps should be 40-watt, deluxe warm white.



FIG. 17. Little daylight and insufficient electric light interfere with speed and precision in sorting out the culls.

If incandescent lights are to be used, 150-watt reflector-flood bulbs have been found to be satisfactory. They are frosted at the bottom end as a means of reducing glare.

The application of a white (or very light colored) paint to the inside walls, ceiling, and tables results in appreciable improvement in light conditions in the building, and provides more pleasant surroundings for the workers.

Water Supply

An ample supply of water for both drinking and washing purposes should be available in the building. If the water is not from a chlorinated municipal supply, it should be tested at an Ontario Department of Health laboratory at the beginning of each season. Drinking should be from a fountain or from small paper cups in a dispenser. The owner should be insistent that each person on the packing crew keep his hands clean.

Toilets

If sufficient water is available, a flush toilet, or toilets, should be in the building or nearby. Failing that, a pit privy should be built at a suitable location at least 50 feet (but not more than 100 feet) from the packing house. (For detail of construction see Ontario Department of Agriculture Bulletin 471, "Rural Sewage Disposal".)

Fire Protection

The building should have its own chemical fire extinguisher in an easily accessible place known to all of the workers. It should be of a type which is not ruined by freezing so that it can be left in place over winter. In addition, there should be sufficient length of hose available near a tap with suitable connection so that water could be sprayed on any section of the building in case of fire. Lightning rods should be installed in accordance with government regulations.

Heating

If the building is to be used for late fall or winter packing operations, some system of heating is essential for efficient work. It may be, too, that off-season uses for purposes other than fruit packing will warrant the installation of heating facilities in part or all of the building. A separate heated room can be partitioned off, with permanent or removable partitions. This arrangement would result in economy of fuel.

Disposal of Waste

There will always be a certain amount of waste fruit in a packing house. Even with a sales outlet for culls there will still be some unsalable fruit — wormy, decaying, or with broken skin. Old hampers are often used as receptacles for this waste fruit but, unless provided with a leak-proof liner, are not satisfactory. Juice on the floor of the packing house is an annoyance and an attraction to flies. Lidded garbage cans are the preferred receptacles. There should be at least one for every two sorters, covered when not in use. Provision for emptying the cans periodically will be part of the plan of operation of the packing house.

Clock

With deadlines to meet at shipping points, a packing house is not complete without a reliable clock, preferably electric. It should be readily readable from all working areas inside the building.

Fly Control

Flies are an annoyance to workers in the packing house and play a part in inefficiency. For that reason and others, there should be no piles of waste — manure, fruit, or garbage in the vicinity of the buildings. When the building is empty, spray floor, walls and ceiling with malathion, (40 lb. 25% wettable per 100 gal.), and repeat about every two weeks, if necessary. Apply at the rate of one gallon per 1,000 square feet of painted surface. Double this rate if surfaces are unpainted. Do not get any of the spray on surfaces which will later be in contact with fruit — graders, sorters, tables, or containers. This will mean removal or covering during the spraying operation.

First Aid

Every packing house should have a simple First Aid kit. It can be purchased as a kit or made up by the grower. In it, should be tincture of iodine or other disinfectant, medical tape, first aid bandages, and scissors.

Insurance

Even before the building is completed it should be insured against fire. A packing house is very vulnerable because of the storage of containers which burn very rapidly. Where the building is isolated from the dwelling, and when fruit is kept overnight, insurance against theft should also be considered.



FIG. 18. Hauling fruit from orchard to packing house is an important phase of the harvest and too much care cannot be observed in the proper selection of suitable equipment.

OFF-SEASON USES

A building which is to be used for its main purpose only two to five months of the year represents a certain amount of "dead weight" the rest of the year. The alert grower will think of other uses for the building the balance of the year. The most likely one is for storage of farm implements and tools. The fact that the floor is usually elevated makes the accommodation of heavy machinery more difficult but not impossible. However, the strength of the floor must be considered.

The packing house may also serve as a workshop but, if used as such, care should be taken that the walls, tables, and graders are protected against damage. Before there is freezing danger, the building could be used for a temporary storage for onions and, later in the season, for dry field beans. Lumber may be stored in the building from one crop-season to another.

FRUIT HANDLING EQUIPMENT

The movement of fruit from orchard to packing house is an important phase of the fruit harvest (Figure 18). Labour employed for this work should be careful and efficient to insure safe transit of fresh fruit to the packing house with little delay and minimum bruising.

No matter how efficiently the fruit-handling equipment has been designed, if the labour employed is incompetent, any gains that might have been obtained by efficient operation will be offset by improper handling and bruised fruit.



FIG. 19. A good two-wheeled trailer but a "back-breaking" way of unloading.

Various arrangements have been developed to transport fruit from orchard to packing house. However, three methods appear to stand out as doing a satisfactory job.

Tractor and Trailer

This is by far the most common practice as fruit growers use a tractor for spraying and tillage work, and a trailer for hauling ladders, containers, and other equipment through the orchard. Since this equipment is available on most fruit farms, no additional capital investment is required for fruit-hauling equipment.

Two-wheel and four-wheel trailers are used, but the two-wheel trailer (Figure 19) is preferred because of the ease of handling. However, when two or more trailers are used with one tractor, then the four-wheel trailer has the advantage in that hitching and unhitching is a simple operation of raising and lowering a short tongue. Nevertheless, the convenience in manipulating a two-wheel trailer around the trees in the orchard has made this the more popular conveyance.

In addition to tractor-drawn trailers, stake trucks with the racks removed are sometimes used to carry fruit from orchard to packing house. However, since containers are spread in a single layer and not stacked, it appears inefficient to use a two- or three-ton truck to move about 100 eleven-quart baskets of fruit. Furthermore, a truck is an awkward vehicle to handle in an orchard.



FIG. 20. Transporting peaches from orchard to packing house. The three-point hydraulic lift picks up 64 six-quart baskets of fruit each trip.

Tractor-mounted Lift and Pallets

A simple steel frame is designed with two prongs and a wide vertical frame to prevent shifting of baskets (Figure 20). This lift frame is mounted to a three-point hitch on the rear of a tractor. The hydraulic-lift mechanism of the tractor raises the unit in transport position. Orchard operations consist of stacking about 64 six-quart baskets in four tiers on a pallet.

The tractor operator simply backs up to a loaded pallet, lowers the fork lift, backs the lift under the load, then raising the load in transit position, drives to the packing house and lowers the load to the packing house floor.

This system is fast and efficient providing the orchard is within a half mile of the packing house. However, the tractor is not operating at maximum efficiency since several trips are required to move the same amount of fruit that can be moved in one trip by tractor and trailer. Nevertheless, the investment in equipment is low, consisting only of the cost of the fork-lift attachment and pallets. The number of pallets required will depend on the tonnage of fruit harvested in one day. It is desirable to have enough pallets on hand for the heaviest day's picking plus a few additional pallets for orchard operations and for carry-over of fruit in the packing house.



FIG. 21. Unloading pears from pallet trailer. The simple hand-lift truck unloads the trailer in six trips.

Hand-lift Truck and Pallets

This arrangement incorporates the advantages of the pallet system and by using a trailer allows the tractor to haul larger loads. Two-wheeled balloon-tired low-bed trailers of special design are required to transport orchard fruit to packing house (Figure 21). These trailers are constructed with a loading platform 2'-10" wide and 15'-0" long. While one trailer is being loaded in the orchard, the other is in transit. Each trailer holds 96 eleven-quart baskets and is easily drawn by a small 9-12 horsepower tractor.

A simple hand-lift truck transfers the loaded pallets from trailer to unloading dock. Later, the lift truck is used to move fruit from holding area to grader and from grader to storage.

While a small investment is required for the trailer, hand-lift truck, and pallets, this appears to be an efficient method of handling fruit on the farm.

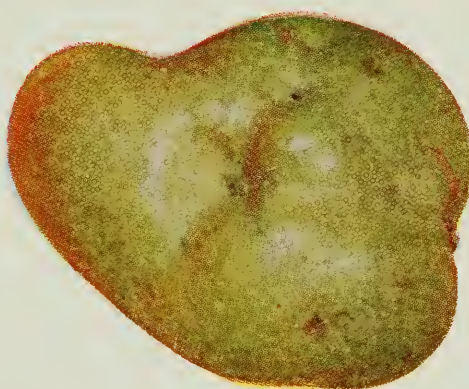
ACKNOWLEDGMENTS

This publication was prepared under the direction of an Ontario Department of Agriculture Committee composed of C. G. E. Downing, George Wilson and W. H. Upshall. The authors acknowledge with thanks the assistance of the Ontario Fruit and Farm Economics Branches and the co-operation of many Ontario fruit growers. Photographs were taken and prepared by the Photographic Division of the Department of Public Relations, Ontario Agricultural College.

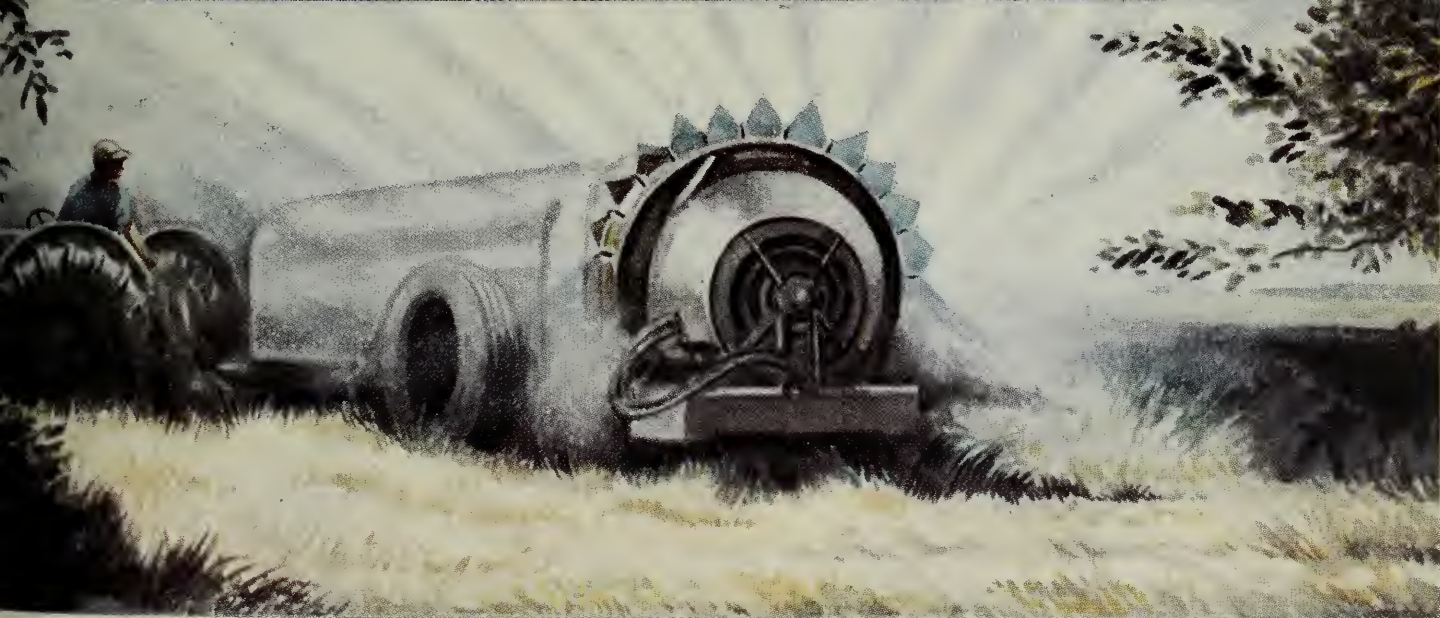




CA20NAF6
B512



Insects *of the* Apple *and* Pear



CONTENTS

	Page		Page
INTRODUCTION	3	Green Fruitworm.....	32
Control Section.....	3	Leafhopper.....	27
Insecticides.....	3	Lecanium Scale.....	36
Equipment.....	4	Oystershell Scale.....	35
Caution.....	4	Pistol Casebearer.....	26
Acknowledgment.....	4	Plant Bugs.....	27
General Control Practices.....	5	Plum Curculio.....	14
APPLE INSECTS	6	Red Mite.....	22
Aphids.....	17	Red-banded Leaf Roller.....	11
Apple Aphid.....	18	Red-humped Caterpillar.....	34
Apple Flea Weevil.....	40	Rose Chafer.....	41
Apple Grain Aphid.....	17	Rosy Apple Aphid.....	19
Apple Leafhopper.....	27	Roundheaded Apple Tree Borer.....	43
Apple Maggot.....	15	San José Scale.....	37
Apple Red Bug.....	27	Shot-hole Borer.....	39
Apple Seed Chalcid.....	41	Tarnished Plant Bug.....	27
Apple and Thorn Skeletonizer.....	33	Tent Caterpillars.....	29
Bud Moth.....	8	Tentiform Leaf Miner.....	34
Buffalo Treehopper.....	42	Two-spotted Spider Mite.....	24
Cankerworms.....	31	Woolly Apple Aphid.....	21
Caterpillars.....	33	Yellow-necked Caterpillar.....	34
Cigar Casebearer.....	24	PEAR INSECTS	45
Codling Moth.....	6	Codling Moth.....	50
Eastern Tent Caterpillar.....	29	Oriental Fruit Moth.....	51
European Red Mite.....	22	Pear Leaf Blister Mite.....	47
Fall Webworm.....	34	Pear Psylla.....	45
Forest Tent Caterpillar.....	29	Pear-Slug.....	49
Four-spotted Mite.....	24	Plant Bugs.....	50
Fruit Tree Leaf Roller.....	10	Other Insects of Pear.....	52

INSECTS OF THE APPLE AND PEAR

by

H. W. GOBLE

Department of Entomology and Zoology,
Ontario Agricultural College, Guelph, Ontario

INTRODUCTION

In this bulletin an attempt has been made to bring together information on the habits, life history, and control of the important insects and mites of the apple and pear. A few unimportant species that are either conspicuous or sometimes confused with important forms are also included.

The write-up on each pest has been prepared basically for the grower and those that advise in the control of insects and mites. The life histories of the various pests have been given to assist in the planning of satisfactory controls. The bulletin is not intended to be complete enough for the teaching of biology in high schools; text books in entomology give more detail. The illustrations show mainly injury to the fruit, foliage, or tree, especially the fruit at picking time. Insect developmental stages which cannot be readily seen by a grower and the identification of which are not pertinent to an intelligent control program are rarely illustrated.

Control Sections

The section on control under each insect is general and short. Experience in chemical control since the common use of DDT indicates that materials or combinations of them based on research and grower use will change slightly from year to year. Insecticide and fungicide combination sprays are not given. This information will be available in each year's spray calendar. If you are a commercial grower, ask your local Ontario Department of Agriculture to have your name added to the Spray Service list. The letters which you will receive give modifications in general recommendations to suit your particular area.

Insecticides

Horticultural insecticides have been greatly improved during the last few years. However, difficulties have arisen such as compatibility with the fungicides and occasional fruit and foliage injury under conditions of wet foliage, high humidity, and extreme heat. Many outlines and books give this information.

The insecticides that are recommended are available from companies handling orchard spray chemicals.

The amount of insecticide given in this bulletin to control each insect is stated in pounds or gallons for 100 gallons of water. If you use a concentrate spray machine, these amounts may be increased to the desired concentration. Tables that give the amount of insecticide to apply per acre, regardless of the gallons of water used, are also available in spray calendars and charts.

Spray Equipment

Equipment that will apply the correct amount of insecticide at the right time is just as important as the material used. High-pressure as well as wind-blast machines are available. Either type is satisfactory provided the machine has adequate capacity for the size of the trees and the orchard.

CAUTION

Before using insecticides, read carefully and follow the cautions given by the manufacturer concerning the safe handling of sprays. Use recommended masks where required to prevent breathing poisonous materials. Do not work in the drift of sprays. Wash the skin thoroughly with soap after working with insecticides.

All of the materials recommended are poisonous. Parathion, TEPP, and demeton (Systox) are deadly poisons. For the safe handling of these materials carefully follow all warnings which are found in every carton and on every container. Do not work in orchards that have been sprayed with parathion, TEPP, or demeton until the required safe period from treatment has elapsed. Be especially careful not to work in spray drift of dieldrin as it is highly toxic and it is readily absorbed through the skin.

ACKNOWLEDGMENTS

The section on apple insects was reviewed by Mr. J. A. Hall, Entomology Laboratory, Simcoe, Ontario. Many of his suggestions have been included in this bulletin. The assistance of Messrs. G. G. Dustan and T. Armstrong, Entomology Laboratory, Vineland Station, was appreciated in preparing the pear insect section. The help of these officers of the Canada Department of Agriculture is gratefully acknowledged.

This manuscript was reviewed by Miss Catharine G. Ball, Publicity Office, Ontario Agricultural College, and the photographs, with two exceptions, were taken by the Photographic Division, Department of Public Relations, Ontario Agricultural College.

GENERAL CONTROL PRACTICES

Sprays are required for the control of almost all of the important pests of apples and pears. However, there are other practices which are very helpful, and a combination of all these with the proper sprays is recommended.

(1) Destroy hawthorns and wild fruit trees on your own property. If trees of this type are on roadways or other property, have them removed if possible within at least 300 yards of the orchard. It is also advisable not to have mountain ash near the orchard.

(2) Prune the trees sufficiently to allow proper spraying. A well-pruned tree is also not as subject to insect attack as one that is very thick.

(3) Remove dead or dying limbs and trees. Burn the brush before June 1. If fruit-tree firewood has not been used before June 1 of the year it was cut, store it in a cellar or shed that can be kept moth-tight or sell it to be removed from the farm.

(4) Store hampers, boxes, and baskets off the farm or in moth-tight storages. It is preferable to store orchard props in the same way. If props are piled in the orchard, spray them with the DDT codling moth sprays.

(5) Bury pulp or feed to livestock all thinnings and culls. If this is not practical, dump them as far as possible from any orchard.

INSECTS of the APPLE

CODLING MOTH

Carpocapsa pomonella (L.)

The codling moth is potentially the most serious insect of the apple. Since DDT has come into use the loss from this pest has been reduced greatly. Even with DDT and other effective insecticides, it may return again as the most important insect in apple production. It attacks the apple, pear, hawthorn, and occasionally other fruits.

The adult is a grayish-brown moth with a $\frac{3}{4}$ -inch wingspread and with a well-marked golden-brown area near the apex of each front wing. The larva



Codling moth larva and injury.

is found in the fruit near the core and is three-quarters of an inch long, white or pinkish in colour, with a brown head. The "worm" in the apple or pear is likely to be the larva of a codling moth.

Injury

There are two types of injury to the fruit: deep entries and "stings". With deep entries the larvae eat through the skin to the core where they do most of their feeding. There are dark brown castings at the entrance holes. The fruit ripens early, usually drops prematurely, and is worthless. The percentage of fruit with deep entries, however, may not be great.



Typical examples of codling moth injury.

“Stings” may occur both early in the season and during August and September. In a severe attack a large percentage of the apples may be affected. The name “sting” is a misnomer since the larvae eat their way through the skin and into the apple a short distance. Frass, that is, chewed material and excrement, will be present at the place of entry. The larvae, after gaining access, either die or desert the “sting”, and then may enter at another place. “Stings” caused early in the season will heal over, leaving a russeted spot on the fruit.

Life History

These insects spend the winter as mature larvae in small cocoons that they spin called “spin-ups”. They are formed on the trunk and limbs, under loose bark, on debris on the ground, on orchard props, in packing cases, packing sheds or any good hiding place. The overwintered larvae transform to pupae in May and June. Adults start to emerge soon after the petals fall and continue over a period of six to eight weeks or longer. The moths lay eggs three or four days after emergence provided the evening temperature is 60° F. or higher and the weather is not windy. The eggs hatch in about seven or eight days depending on the temperature. Moths lay practically all their eggs within 200 to 300 feet of the place of emergence provided fruit is readily available; otherwise they fly a considerable distance until fruit is found.

Upon hatching, the larvae seek the fruit and enter at any place where they are able to pierce the fruit with their mouthparts. In a few days they reach the core where they feed on the seeds and pulp. They complete their development as larvae in four to five weeks and leave the fruit usually by the place of entrance. By this time most of the infested fruit will have dropped. In the southern part

of Ontario there is almost a complete second brood. At Georgian Bay and in areas of similar temperature there is a partial second generation with an almost complete second brood if the average temperatures for the season are above normal, such as occurred in 1949 and 1955.

Control

A great number of codling moth larvae are controlled by parasites, insect predators, and birds such as woodpeckers and chickadees. Some larvae die of disease.

Sprays are required in all parts of the Province to obtain adequate control. A good control schedule is based on the principle of killing as close to 100 per cent of the first brood as possible. Otherwise sprays will be required for the second brood in August.

DDT has been the best of the materials used to date. Two pounds of 50% DDT wettable powder in 100 gallons of spray are recommended. Make the first application about one week after the first egg laying. This will be early in June in the southern parts of the Province and later in other areas. Follow the spray schedule for your area through June and July.

Lead arsenate, a material used regularly for codling moth before DDT was available, still gives satisfactory control in a few orchards in some areas. It is not satisfactory, however, in the areas bordering Lakes Erie and Ontario.

DDD (TDE) and methoxychlor are effective against codling moth although not equal to DDT; they are, however, of value when required for control of other pests such as red-banded leaf roller and plum curculio. Parathion and other phosphate insecticides kill codling moth but because they do not give as long a period of protection in the spray schedule they should not be relied on alone.

Because ryania will control codling moth without killing many of the beneficial parasites and predators, there is interest in this insecticide. However, since this material kills very few other injurious pests of the apple, it has not been included in the apple spray schedule for Ontario up to 1956.

Consult the Ontario Spray Calendar for Apples and the spray service letters for the exact time and number of applications for your area.

BUD MOTH

Spilonota ocellana (D. & S.)

The eye-spotted bud moth is the species of bud moth troublesome to Ontario apple and pear growers. For some unknown reason it has been more destructive and difficult to control in some areas such as eastern Ontario, and Oxford and adjacent counties. Some growers have great difficulty with this pest yet it may be of little importance in neighbours' orchards. It attacks the buds, leaves, and fruit of all kinds of orchard trees and some ornamental trees and shrubs.

The adult is a grayish-brown moth with a ½-inch wingspread. It has a grayish-white irregular area on each forewing, thus the name "eye-spotted". The larva is a cinnamon-brown caterpillar with a black head and is about two-fifths of an inch long when mature. The brown colour of the body distinguishes

it from the greenish larva of the other common species of leaf rollers as shown in the illustration on page 25.

Injury

Early in the spring the larvae bore into the buds and continue to feed in the opening buds and leaves until June. With heavy populations considerable bud injury may result with a large percentage of the blossom buds being destroyed. These larvae may feed on the fruit to a limited extent early in June.

By far the most important injury occurs in the fall. Wherever leaves with bud moths on the underside touch a fruit, the larvae web it to the fruit and feed underneath eating small holes through the skin of the fruit. Although these



Apples injured by bud moth. Note the pale colour near the injury indicating the position of a leaf that was webbed to the fruit.

holes look like codling moth “stings”, they are in groups and the openings through the skin will not be full of frass as shown in the illustration on the cover. Fruit injury in some orchards and on some varieties in the fall may be 20 per cent or even higher.

Life History

There is one generation a year. The bud moths pass the winter as partly grown larvae in little inconspicuous cases called “hibernacula” in rough places on the twigs or at the base of the buds. When the buds show green at the tip

the larvae leave their winter quarters and bore into the buds where they feed on the opening leaves, blossom buds, and sometimes the small fruit until about the middle of June. Then they pupate in these leaves. The moths emerge the end of June and in July, with the peak of moth flight about July 15. The eggs are laid on the leaves. Upon hatching the larvae web-in against the veins where they feed, as described previously under "Injury" until September, when they form the hibernacula in which they winter.

Control

The regular sprays recommended every year for all apple orchards often do not control this pest. Thus if there was injury in your orchard the previous year or if this pest is present in numbers, apply a special spray. Use one of the following:

(a) A dormant spray of a 40% dinitro cresol paste at 4 quarts to 100 gallons of spray.

(b) When buds are at the green-tip stage, 15% parathion wettable powder at 1½ pounds to 100 gallons of spray.

(c) When all the eggs have hatched in the summer, that is, about the last week in July, spray with 25% malathion wettable powder 2 pounds, or 15% parathion wettable powder 1½ pounds, in 100 gallons of spray. This spray is more effective when the temperature is above 70° F. Cover one side of the trees and immediately spray the other side.

FRUIT TREE LEAF ROLLER

Archips argyrospila (Wlkr.)

The adult of the fruit tree leaf roller is a moth with a wingspread of nearly an inch and the front wings rusty-brown marked with silver-grey. The larva is a slender caterpillar about an inch long when full-grown and yellowish-green in colour. The head on the young caterpillar is black or chestnut, and on mature forms dark-brown. These colours will distinguish it from the larvae of the bud moth and red-banded leaf roller, two caterpillars found in similar locations in May and June. See the illustration on page 25.

Injury

The larvae feed on the buds or opening leaves in May and June, and when about half-grown may feed on the small apples in or under the protection of several leaves. Later in June they eat deep gouges in the fruit. Most of the injured apples drop; those that remain on the tree will be deformed and gnarled by picking time as shown in the top-left picture on cover. These pests are rarely a problem in all orchards or on all varieties the same year, but they are a constant threat to the fruit grower. They attack pears, plums, cherries, peaches, and some other fruits.

Life History

These insects spend the winter as small, brown, oval clusters of eggs about

one-quarter of an inch in length mostly on the upper surface of twigs and small branches. They hatch soon after the leaf buds on apple trees open and feed on the opening leaves. Later they fasten leaves together and feed from inside the shelter thus formed. When the fruit forms they feed on it in preference to the leaves, eating gouges that may extend to the core. The larvae are full grown in five to six weeks. The pupae are formed in a rolled leaf or on the ground. Moths emerge in about two weeks and lay eggs on the twigs, thus completing the cycle. There is one generation a year.

Control

In most apple and pear orchards where DDT has been used in the regular sprays at or about calyx stage, this pest has been almost eliminated. If you have not planned to use DDT at this time, examine your orchard just before petal fall and if this leaf roller is present, apply 50% DDT wettable powder 2 pounds in 100 gallons of spray at calyx time.

An alternative method is the use of 4% dormant oil emulsion as a dormant application or in combination with the delayed dormant bordeaux to kill the eggs that are on the twigs.

RED-BANDED LEAF ROLLER

Argyrotaenia velutinana (Wlkr.)

The red-banded leaf roller has become a problem in many apple orchards since about 1948. Previous to this, apple orchards received large numbers of



First-brood injury of red-banded leaf roller on fruit and leaves.



Second-brood injury of red-banded leaf roller on fruit.

lead arsenate sprays from delayed dormant or pre-pink stages until the end of July. This kept this pest under control.

The insect's name is derived from the reddish oblique band on the front wings of the adult moth. The larva is a caterpillar about the same size as the fruit tree leaf roller but is pale in colour with a pale- or yellowish-coloured head.

Injury

The first brood feeds first on the undersides of the leaves, where it forms a clean, white web close to the veins but causes little damage. Later, under the protection of a leaf, they feed on the small apples. Injured apples drop or are deformed at harvest. The second brood and, in some years, a partial third brood cause the most severe damage. When small they, too, form a clean, white web on the undersides of the leaves but later feed on the skin of the fruit under the protection of a leaf or where apples are in clusters. Apples attacked have an irregular area of skin eaten from the fruit. The second and third brood may still be feeding at picking time. While all varieties of apples are subject to attack, the Cortland and Greening are especially susceptible.

These pests may attack also the pear, peach, plum, cherry, and other fruit.

Life History

There are two complete generations a year with a partial third in the more southern areas. The insects spend the winter as pupae under the trees on debris or in rolled leaves, or on packing cases. Moths emerge from the time the buds burst until the pink stage is reached. The eggs of the first generation are laid in clusters on the larger limbs from time of pink stage through the bloom period. On hatching, they crawl immediately to a leaf where they form a white web along a vein on the underside. Since eggs are laid mostly on larger limbs,



Eggs of red-banded leaf roller on bark (greatly enlarged).

larvae will be more plentiful on the leaves on suckers and on the inside of the tree. When about half-grown they seek and feed on the fruit. They pupate the end of June, moths emerging in July. The eggs of the second brood are laid on the leaves late in July. The full hatch of the second brood is about the first week in August. The larvae web in the undersides of the leaves, as do the first brood. When about half-grown they also seek the fruit where, feeding under the protection of a leaf or in a cluster of apples, they eat the skin. They pupate in the fall in any suitable hiding place, where they spend the winter. Some of the pupae that develop in late August emerge as moths to form a partial third brood.

Control

DDD (TDE) is very effective against both first and second brood. Use 50% DDD (TDE) wettable powder 2 pounds in 100 gallons of water in the first cover spray and, if necessary, in early August after the full hatch of the second brood.

Lead arsenate, while not recommended if a heavy population has developed, is likely to prevent or retard a build-up if used in the calyx and first cover sprays. Parathion, while not as effective as DDD, will give very good control and may be applied for either the first or second brood of the red-banded leaf roller where mites and some other pests require control at the same time.

PLUM CURCULIO

Conotrachelus nenuphar (Hbst.)

The plum curculio is primarily a pest of the plum, peach, and apricot. It may cause severe damage in some apple orchards, where it is one of the most difficult pests to control while, in others it has not been important. It usually is very destructive on home-garden apples.

The adult is a dark-brown snout beetle about one-quarter of an inch long. It has a strong, curved snout about one-third the length of the body. The larva is a grub that develops in the fruit.

Injury

These insects cause injury in the spring during egg laying since the female deposits the egg in a round hole eaten in the skin of the fruit and then makes a crescent-shaped cut in the skin below it as shown below. Therefore, whether the egg hatches or not, a D-shaped scar develops on the fruit. In the fall the adults feed by eating small holes through the skin of the fruit and then, by means of their snouts, eating cavities beneath this hole as shown in the bottom-left on the cover.

Life History

They winter as adult beetles in any protected place either in or out of the orchards. About the time apples bloom and when it is warm, they fly to the



D-shaped scars on mature fruit caused by egg-laying "cuts" of plum curculio in June.

trees and feed on the leaves and blossoms. These curculios have the habit of abandoning the trees and even the orchard if a cold period follows their first movement to the trees; they return, however, when weather is favourable. Egg laying commences when the fruit has set with the female making the characteristic "cuts". Upon hatching, the larvae work their way through the flesh and the core of the fruit. Most of the fruit in which larvae develop drop early. The larvae emerge and pupate in the ground, and adults appear in August. These adults cause the fall feeding injury before going to winter quarters.

Control

This is a very expensive insect to control since the materials used in spray schedules for other pests may not be effective. DDT has little value for curculio. Lead arsenate sprays appear to keep the pest from gaining headway but do little to clean up a heavy infestation. Fifty (50) % dieldrin at $\frac{3}{4}$ pound or 50% methoxychlor at 3 pounds in 100 gallons of spray each have been used in both the calyx and first cover sprays. For the actual use and combination with other insecticides for your area, use the curculio spray schedule for your district.

APPLE MAGGOT

Rhagoletis pomonella (Walsh)

The apple maggot, or "railroad worm", is one of the most serious pests of the apple. Its importance has increased during the last few years possibly



Apple maggot fly on fruit.



Apple maggot injury. Top: pin-prick marks on skin caused by egg laying; bottom: cut section shows brown streaks in flesh made by the maggots.

because it has not been well controlled by many of the new insecticides that have been so effective against other pests. It is so difficult to control on home-garden apple trees that, generally speaking, it is not advisable to plant other than commercial orchards. The maggot itself is so small until the fruit is over-ripe that it is seldom seen. When full-grown it is about one-fifth of an inch long. The adult is a fly slightly smaller than a house fly with a characteristic black mark on each wing.

Injury

Infested apples have winding streaks of brown, corky flesh wherever the maggots have been; these streaks give the apple maggot the alternative name of "railroad worm". If the infestation is light the only evidence from the outside of the apple may be tiny pin-prick-size punctures, usually with a violet halo, through the skin. If the maggots wander through the flesh near the skin, brown, depressed areas may appear. Heavily infested fruit from unsprayed trees will be deformed. Almost every variety of apple may be attacked. Some of the most susceptible are Tolman, Transparent, Wealthy, and Snow. Spy is moderately susceptible with McIntosh more resistant.

The host plants are mainly apples and hawthorns. Plums and prunes are sometimes attacked, particularly if they are near infested apples. The pear is immune.

Because of apple maggot infestations, the export of apples from Canada to countries other than the United States is prohibited unless the orchards are under apple maggot certification.

Life History

The apple maggot spends the winter in the pupal stage in the soil under the trees. Flies emerge from the last week in June through July with a few appearing in August and even September. The peak of fly emergence is likely to be between July 15 and 25. The adults begin to lay eggs about a week after emergence, inserting them below the skin of the fruit. The eggs hatch in about five days. The maggots, remaining small until the apple is ripe, wander through the flesh of the apple. When the apple is over-ripe or starts to decay, the maggots emerge fully grown from the fruit. They enter the soil, pupate, and remain there until the following year. A few pupae remain in the soil for nearly two years and emerge the second summer.

As stated before, the adults do not lay until almost seven days after emergence. During this time they feed on juices, moisture, and small particles on the leaves. This manner of feeding is important because it is during this period that they must be poisoned. No practical way of killing the eggs or young maggots in the fruit has been found.

Control

Cut down all wild apple trees and hawthorns within at least 300 yards of the orchard. A fruit grower should eliminate all of these trees on his own property regardless of their distance from the orchard. It is advisable not to plant ornamental crabs near apple orchards unless they will receive the apple maggot sprays. Have municipalities co-operate concerning the removal of wild apple and hawthorn on roadsides.

Lead arsenate at 4 pounds to 100 gallons of spray will give the best control. DDT is effective but sprays of DDT are required about every 10 days. A combination of lead arsenate at 2½ pounds plus 50% DDT at 2 pounds to 100 gallons of spray applied about every 12 days during July has given good control. Consult your regional spray letters and calendars for time and number of applications.

Spray all trees in the orchard, whether they have fruit or not, and any other apple or hawthorn trees within 300 yards of the orchard; spray also the side next to the orchard of any other trees or hedges bordering the orchard.

APHIDS

There are four species of aphids that are injurious to, or common on, apples: the apple grain aphid, apple aphid, rosy apple aphid, and woolly apple aphid. The apple aphid and rosy apple aphid are the most destructive of these.

APPLE GRAIN APHID

Rhopalosiphum prunifoliae Fitch

These aphids spend the early part of the season on the apple, and the rest of the summer on grain and grasses. They are usually the most abundant aphid on the buds in the spring; in fact some years they are so abundant that they

almost cover the green tissue on the opening buds. Although they may cause the leaves to curl slightly, they cause very little damage because they leave the apple early in the season. Wing pads start to form on the apple grain aphids in May and during June, and when their wings have developed they fly to the grain.

Since this species causes very little damage it is not necessary to use sprays against them.

APPLE APHID

Aphis pomi Deg.

This is the most important species of aphid on apple. It is often referred to as the green apple aphid. The young appear early in the spring when the buds burst and at that time are difficult to distinguish from the apple grain aphid. However, the apple aphid may be distinguished from the apple grain aphid as follows: (1) The head of the apple aphid is pale-brown except during the first stage after hatching, while that of the apple grain aphid is green; (2) The abdomen is uniformly yellowish-green, whereas that of the apple grain aphid has pale cross stripes; (3) The cornicles, or tubes, on the abdomen are longer on the apple aphid.

Injury

These aphids suck the sap from the leaves, particularly near the growing tips, thus stunting the growth. The greatest damage to the fruit is likely to be caused by a sooty fungus that grows in the sticky material known as honeydew secreted by the aphids. This fungus stains the fruit thus reducing its market value, particularly on dessert varieties. This injury is illustrated on page 25. All varieties of young trees are susceptible to severe injury. Mature trees especially subject to attack are Snow, Scarlet Pippin, Gano, Spy, Greening, Tolman, and Delicious. In 1954 the green aphid was the most destructive pest of the apple in some areas.

This aphid will attack also the pear, hawthorn, wild crab, spiraea, and some other trees.

Life History

They spend the winter as eggs at the base of the buds. These hatch as the buds burst. During the season a large number of generations develop of which most are wingless. Winged forms appear from time to time and fly to other parts of the same tree or to other trees either in the same or nearby orchards. Early in the season they may become very abundant on the sucker growth. In the fall winged females lay eggs again at the base of the buds for winter.

Control

Orchard practices that will keep the trees in a uniform growing condition, that is, without excessive growth in any one year, are helpful. Apply the correct amount of fertilizer at the time that will give growth before July 1 with the wood starting to mature and harden by that date.

If aphids develop in large numbers on the suckers in June or early July, pull the suckers off.

It is difficult to decide when to spray for aphids on bearing trees. The time is sometimes determined by the previous history of the orchard. If more than a few tips become infested, apply a spray. Nicotine sulphate plus soap or spray lime have been the standard materials for aphid control for years and they are still used. However, since the newer phosphate materials control mites and some other pests at the same time, they have largely replaced nicotine. Malathion, TEPP, and parathion have been in general use. A still newer phosphate, demeton, a material that is carried in the sap of the tree and thus taken in by the aphid when it feeds, is effective. The actual rates and formulations are found in the current spray guides. In general, wettable powder forms are safer to use than emulsions.

The method of application is important since most of the materials kill aphids partly by poisonous fumes. All are more effective at high temperatures and when the weather is calm. Complete the spraying of both sides of the trees in one operation; otherwise, spray one side of the row and immediately spray the other side.

ROSY APPLE APHID

Anuraphis roseus Baker

As the name implies, this species has, except for a few days after hatching, a pinkish tinge and is lightly covered with a whitish powder or bloom. In certain



Rosy apple aphid injury to leaves and fruit early in the season.



Dwarfed apples at picking time caused by rosy apple aphid in June (scale shown in inches).

years this pest may be very destructive while in other years it causes little damage.

Injury

Injury is caused early in the season. The rosy apple aphids cause more rolling of the leaves than the other species. When plentiful they attack the apples as soon as they have set. Injured apples are dwarfed, their ends wrinkled, and they hang on the trees in clusters even after the normal fruit is ripe. Varieties which are particularly susceptible to attack are Cortland, Tolman, Rhode Island Greening, Spy, Jonathan, and some other varieties.

Life History

Eggs are laid at the base of the buds in the fall and hatch about a week to ten days after those of the apple aphid. The young feed on the leaves and fruit as described previously. In July winged forms appear that fly to the alternative hosts: the ribgrass and broad-leaved plantain. They remain on these weeds until fall when winged males and females appear; after mating, the females lay eggs at the base of the buds to complete the cycle. The interesting habit of this aphid is its ability to distinguish at egg-laying time a Cortland from a McIntosh, which is seldom attacked.

Control

Since this aphid does not move from tree to tree in the spring or summer, dormant sprays that kill the overwintering eggs are very effective. Use a $\frac{1}{2}\%$ spray of 40% dinitro cresol paste (Dinitrosol, Elgetol, or Krenite 2 quarts in 100 gallons of water).

An alternative, less effective spray is parathion or nicotine sulphate in the delayed dormant spray. Phosphate sprays such as are given under "Apple Aphid" may be used until bloom time, but they are only moderately effective since the infested leaves will be rolled by that time.

WOOLLY APPLE APHID

Eriosoma lanigerum (Hausm.)

The woolly apple aphids attack the bark and roots. These aphids are covered with a conspicuous, white, waxy material. Clusters of them resemble little tufts of wool or cotton-batting. Except in a few orchards these aphids have not been very destructive in Ontario.

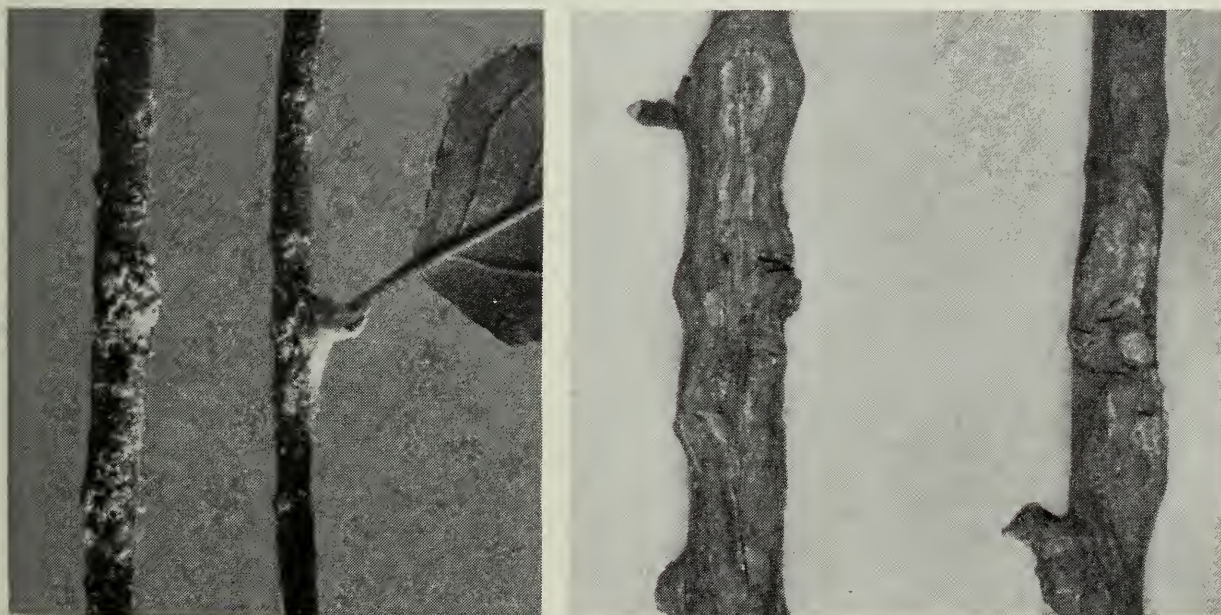
They attack the apple, pear, mountain ash, and hawthorn.

Injury

Where clusters of aphids feed on the bark during the summer, swellings develop which may rupture, and callous areas develop along the sides. These often are not noticed by growers until pruning time. The roots may be attacked also.

Life History

They have a complicated life cycle with the elm as the alternate host.



Woolly apple aphid. Left: aphids in summer; right: injury to twigs.

A few eggs may winter on the apple. Those that spend the winter on the elm fly to the apple during the early part of the season.

Control

Control is rarely required in Ontario. Nicotine sulphate and soap may be used with the spray being applied under high pressure in order to drive the spray through the waxy covering on the aphids. Parathion, malathion, and TEPP are effective also. Regardless of which material is used, spray thoroughly to wet the aphids on the branches and trunk of the trees.

EUROPEAN RED MITE

Paratetranychus pilosus (C. & F.)

The European red mite has become one of the major pests of the apple from the time of the use of fine sulphur sprays, DDT, and other new insecticides. While some other factors may have attributed to this increase, the main one seems to be destruction of beneficial parasites and predators by the insecticides and fungicides now used on the apple and pear.

The adult is reddish-brown, unspotted, and about 1/75 inch long, in other words, just visible to the naked eye. The eggs are reddish in colour and are large in size compared to the adult mite.

Injury

These mites suck the sap from the leaves. In light infestations the leaves show a specking, while in heavy infestations the leaves become pallid and bronzed. From a distance the bronzing effect gives the appearance of trees covered with dust. The size of crop and amount of tree growth are reduced. Trees heavily attacked are not likely to bear so heavily the following year.

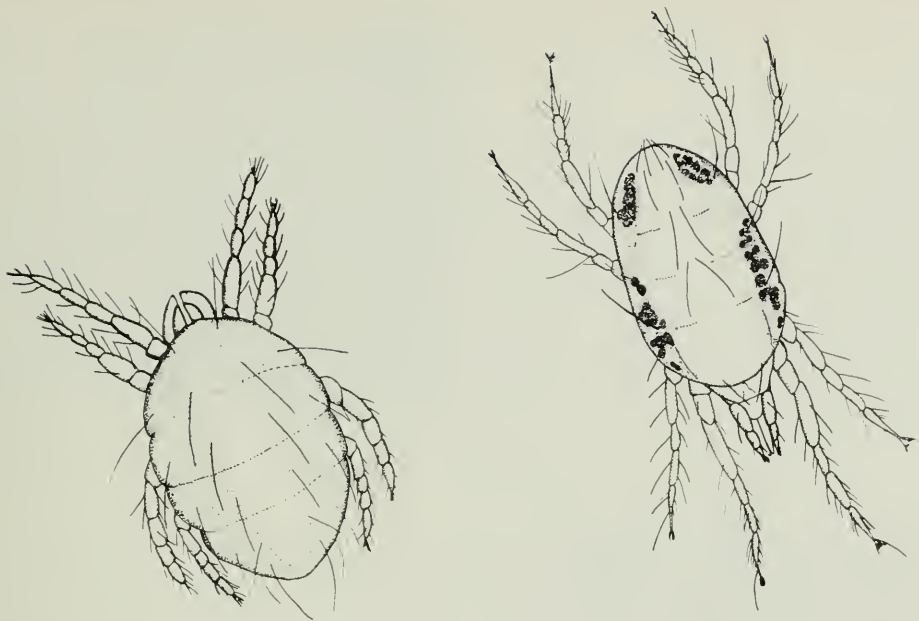
European red mites attack also the pear, plum, prune, cherry, and other fruits, as well as some deciduous trees and shrubs. Apple varieties particularly susceptible are Delicious, Snow, Yellow Transparent, Northern Spy, and Wealthy.

Life History

They spend the winter as eggs in roughened areas on the small twigs and at the base of the buds. The eggs hatch in the spring before bloom. The nymphs immediately crawl to the unfolding leaves where they feed and, under high temperatures, develop to adults in two or three weeks. These adults lay eggs mostly on the undersides of the leaves. A new generation develops and thus through the summer all stages are found on the leaves at the same time. The average time required to complete a generation is about 21 days, there being typically six or seven generations a year. In August and September the last generation lays winter eggs on the twigs.

Control

This species, as well as some of the other mites, is one of the most difficult



European red mite on left, two-spotted spider mite on right.

to control on apples. They have not been so injurious on the pear although occasionally heavy attacks occur on it.

The methods for control of this mite have changed during the last few years as better insecticides have become available. Also mites in some orchards have developed strains that are resistant to certain insecticides and thus a change in material is required. Since the control is not stabilized general methods only will be given in this bulletin, with current spray calendars and spray letters giving the up-to-date recommendations.

Oil emulsions applied at the dormant or delayed dormant stage will kill the overwintering eggs. Provided a very thorough job of spraying is done, excellent results may be obtained. However, if a few eggs are missed, infestations are likely to reach injurious numbers before mid-summer. Either 3% regular type or 2% superior type oil emulsion may be used in the delayed dormant bordeaux spray.

Another method that has given excellent results is the addition of an insecticide such as Ovotran (p-chlorophenyl p-chlorobenzenesulphonate) or Elimite (p-chlorobenzyl p-chlorophenyl sulphide) in small dosages either to the pink and calyx sprays or to one or more of the cover sprays, starting at the first as directed by the local spray service. These materials, although slow in killing adults and thus not quick enough for summer treatments, kill the eggs and young and thus are used in a preventive schedule. This method appears to be the most promising at the present time.

If an infestation develops in July or August, apply two sprays of parathion, TEPP, malathion, or Aramite with an 8- to 10-day interval. These materials do not kill the eggs, thus the second application is necessary to kill the mites which have hatched from eggs which were present when the first spray was applied. If the interval is longer than 10 days, mites will have matured and laid more eggs thus making a third application necessary. Follow your local spray service letters for information concerning the amounts to use and the newer miticides that may be recommended.

TWO-SPOTTED SPIDER MITE

Tetranychus bimaculatus Harvey

The two-spotted spider mite may be distinguished from the European red mite by its pale colour and the usually present two darker areas on its back. The colour varies somewhat with the food. Late in the season the spots may be indistinct or absent. A closely related species known as the four-spotted mite, *Tetranychus canadensis* (McGregor), is similar in appearance, habits, and control, so that what pertains to the two-spotted species will also apply to the four-spotted spider mite. These two mites have been a problem in a few orchards only where they have increased to destructive numbers in August and September.

Injury

The injury is caused by the mites sucking the sap from the leaves, which turn a rusty-brown colour when heavily attacked. They cause webbing on the leaves in which the eggs, cast skins, and sometimes the mites are suspended. The mites themselves move within the webbing or on the leaf.

These mites attack a great many plants as well as trees and shrubs. They are commonly found on clover and weeds in the orchard cover crop.

Life History

Two-spotted mites spend the winter as adults under the bark of the tree trunk near the ground and under the debris on the soil. It is unlikely that any survive the winter on the limbs of the tree. In the spring the mites feed and develop first on the cover crop in the orchard. Many generations are produced throughout the summer and later in the season, usually late July or August, the mites may move into the trees. If a heavy population develops, they will continue into September. They move down to the lower part of the trunk, grass, and debris for winter.

Control

Dormant or delayed dormant oil sprays are not effective against these mites because they are not in the trees when these sprays are applied. The materials applied for European red mite in the cover sprays may help. However, if these mites develop late in the season, use two sprays 10 days apart of one of the following: 15% Aramite wettable powder 1½ pounds, 25% malathion wettable powder 2 pounds, 15% parathion wettable powder 1 pound, or 40% TEPP liquid ¼ pint, in 100 gallons of water. Follow the directions for use which are given by the manufacturer concerning toxicity and the time from harvest that application is allowed in order to avoid excessive residues.

CIGAR CASEBEARER

Coleophora occidentis Zell.

This insect, except in the early stage, is concealed in a cigar-shaped case and thus is easy to identify. In its earliest stage it is present in a small curved



Left: bud moth larva; right: fruit tree leaf roller larva.



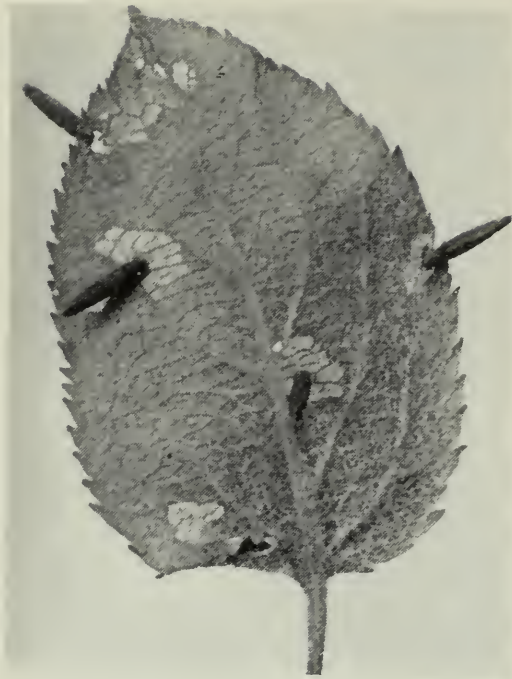
Apple leafhopper injury.



Small black "flecks" caused by apple leafhopper.



Black, sooty fungus on fruit caused by an aphid infestation.



Cigar casebearer. Leaf showing casebearer and injury; apple at harvest with injury caused by casebearers in June.

case. The mature case is about one-third of an inch long and projects at right angles from the leaf. The adult is a delicate, steel-grey moth about the size of a clothes moth.

The case of the pistol casebearer, a related species with similar habits, is shaped like a pistol.

Casebearers are only occasionally important in commercial orchards. At times they may almost completely defoliate uncared-for trees. They attack the apple, pear, and other tree fruits.

Injury

The larvae feed by eating small holes in the upper surface of the leaf; later, without leaving their cases, they eat the tissue within the leaf like a leaf miner. This causes brown, dead spots on the leaves. At times they attack the fruit after it is set and fruit injured at this time drops early or is deformed at picking time.

Life History

These insects spend the winter in little, curved, brown cases in the axils of the twigs or in a rough area on the small branches. They move to the buds as they burst in the spring and feed on the unfolding green of the leaves. These small, curved cases are enlarged and then abandoned for the cigar-shaped cases. The larvae are full-grown by the end of June; they pupate in the case and the small moths emerge in July. Eggs are laid on the leaves. The new larvae work as leaf miners for a few days and then form small, curved cases from which they feed on the leaves. Early in September the larvae, taking their cases with them, migrate to the axils of the twigs to spend the winter.

Control

The insecticides in the regular spray program required for other insects usually give adequate control. Where there has been a heavy population the previous year or if numbers of the small overwintering larvae are present, apply a dormant spray of 1% dinitro cresol paste (4 Imperial quarts of Dinitrosol, Elgetol, or Krenite in 100 gallons of water).

APPLE LEAFHOPPER

Empoasca maligna (Walsh)

Since both the nymphs and adults of this insect are pale in colour, it is often referred to as the white apple leafhopper. This insect was of general importance before the use of DDT and the organic phosphate sprays and now it is likely to be most injurious in orchards where these materials have not been used.

Injury

Both the nymphs and adults cause white stippling where they have sucked the sap from the leaves. Large numbers of spots may coalesce to give a generally blanched, mottled appearance. The second brood may speckle the fruit with excrement, making it unsightly. The speckling is conspicuous on varieties such as Rhode Island Greening. See pictures on page 25. Apple leafhoppers feed on many other plants in addition to apple trees.

Life History

They spend the winter as eggs in the bark of the apple, rose, and other plants. The nymphs, which hatch about calyx time, look like aphids but do not have cornicles, and they move very quickly on the leaf. Adults appear in July, and the second brood of adults, which appears in September, lays eggs in the bark for winter. There are two broods a year.

Control

Use 50% DDT wettable powder 2 pounds in 100 gallons of water in the calyx spray. Leafhoppers are likely to be controlled if DDT is used in the regular sprays for codling moth. Malathion will control them also.

A less effective spray is 40% nicotine sulphate 1 pint applied with 100 gallons of fungicide spray at calyx time.

PLANT BUGS

Several species of plant bugs attack the apple and pear in Ontario. Two of the most common are the tarnished plant bug, *Lygus oblineatus* (Say), a



Lecanium scale.



C-shaped "cuts" made by plum curculio during egg laying.



Plant bug injury.



Black, sooty fungus on fruit caused by pear psylla.

species that is coppery-brown in colour, and the apple red bug, *Lygidea mendax* Reut., one that is red.

Injury from plant bugs has been restricted to some orchards only.

Injury

Both adults and nymphs suck the juice from the leaves and fruit; the fruit injury is more important. The area on the fruit that is punctured during the insects' feeding does not develop normally; instead a depression develops. Sometimes instead of a depression a small elevation develops on which there is a russeted scar. Both types of fruit injury are shown on page 28. Often a little streak extends from the injured area a short distance into the fruit.

Life History

Tarnished plant bugs spend the winter as adults in protected places in or near the orchard, and apple red bugs and other species lay eggs in the twigs for winter. Nymphs from all species hatch about the time the blossom buds are bursting. The nymphs feed on and hide in the unfolding leaf buds until the adult stage in July. The adults either lay eggs and die or overwinter as adults until the next spring depending on the species.

Plant bugs develop on many other plants, particularly weeds and hay. Migration from weedy fields may occur in the spring when buds on trees and nursery stock are bursting. Mowing of weeds or the cover crop in the orchard, or hay in adjacent fields, often causes a heavy migration to the trees.

Control

Apply 50% DDT wettable powder 2 pounds in the calyx spray. DDT in the July sprays as used in codling moth control will kill many of those that migrate to the orchard at that time.

Cleaning up of weeds and destruction of favourable hibernating places will assist in controlling plant bugs.

TENT CATERPILLARS

The eastern tent caterpillar, *Malacosoma americanum* (F.), and the forest tent caterpillar, *Malacosoma disstria* Hbn., are periodically numerous enough to defoliate unprotected orchards. They occur in cycles of about ten years but may remain in abundance for two or three years in succession during the 10-year period. Attacks are more common in the more northern apple-growing areas, such as Georgian Bay and eastern Ontario.

The adults are rusty-brown moths. The two crossbands on each front wing of the eastern species are white, while those of the forest tent caterpillar are dark-brown. The two caterpillars may be differentiated by a white strip on the back of the eastern and white dots on the back of the forest tent caterpillar.

Injury

The trees may be defoliated by either species. These caterpillars attack many other broad-leaved trees in addition to all fruit trees.



Tent caterpillars. From left to right: forest tent caterpillar, eastern tent caterpillar, eastern tent caterpillar "tent".

Life History

The caterpillars pass the winter as egg masses in bands around the small twigs. These eggs hatch at the time the buds burst. The larvae of the eastern tent caterpillar remain in colonies and construct in the crotches of small limbs little webs which they gradually enlarge to tent-like structures. The caterpillars return to these "tents" when not feeding. They are full-grown by June at which time they leave the "tents" and wander in search of a place to spin their cocoons and pupate. Adult moths appear late in June or July and eggs are laid in July for winter. There is one brood a year.

Forest tent caterpillars develop similarly except they do not form "tents" and the caterpillars feed anywhere on the tree or even migrate to nearby trees. In a year of heavy attack of this species, they may migrate from nearby woodlots or fence rows to the orchard trees.

Control

The parasites, particularly a large, hairy fly, are very important in control of tent caterpillars. They are the cause of the caterpillar population's diminishing two or three years after an outbreak. Orchards require sprays for these caterpillars during an outbreak.

Almost any of the insecticides will control them, but DDT or lead arsenate are generally recommended because these materials give a long period of protection. If these insects are numerous enough to warrant control, add 50% DDT wettable powder 2 pounds to 100 gallons of one of the scab sprays before bloom. Since the caterpillars are easy to kill when small, it is preferable to add this poison at the pre-pink spray. Alternative materials are lead arsenate 3 pounds or calcium arsenate $2\frac{1}{2}$ pounds in 100 gallons. To reduce possible leaf injury from calcium arsenate, add 5 pounds of hydrated spray lime to each 100-gallon lot.

CANKERWORMS

Two species of cankerworms infest our orchards and forests: the fall cankerworm, *Alsophila pometaria* (Harr.), whose moths emerge chiefly in the fall, and the spring cankerworm, *Paleacrita vernata* (Peck), whose moths emerge in the spring. These insects, like the tent caterpillars, occur in outbreak proportions periodically and, once the population is high, are likely to occur in an area in destructive numbers for several years until parasites reduce their numbers. Thus they are always a threat to fruit growing.

The larvae are "looper" caterpillars. They have only two or three pairs of pro-legs on the abdomen and are slim in form. When disturbed they drop from the trees on a thread. The adults are moths; the male is light greyish-brown while the female is wingless, thus appearing grub-like.

Injury

Serious attacks are only occasional but complete defoliation may occur when attacks are of outbreak proportions. The caterpillars feed on shade trees, in addition to all fruit trees, and also on the small fruit in June.

Life History

The moths of the fall cankerworm appear in the fall and the eggs are laid in clusters on the trunk and branches, where they remain for winter. Spring cankerworms spend the winter as pupae in the ground. Moths emerge in the spring and females of both species crawl up the trees to lay their eggs. The larvae,



Cankerworms, or "looper" caterpillars.

or loopers, hatch as the buds burst and feed on the opening buds and the leaves. These feed until June, when they drop to and pupate in the ground, remaining there until fall or spring, depending on the species. There is one brood a year.

Control

Control by parasites, birds, and other predators is very important. Sprays are required when the population is high.

When control is necessary, use the same materials which are given in the discussion of tent caterpillars. If large elms and other trees are close to the orchard when cankerworms are very plentiful, it may be necessary to spray them also.

GREEN FRUITWORMS and CUTWORMS

Grapholitha spp.

There are several species of green fruitworms. The larvae are stout, pale-green caterpillars at least an inch long when full-grown. Their heads are a very light-green, and down the middle of the back and each side is a cream-coloured stripe. The adults are stout, greyish-brown moths. Green fruitworms are only occasionally important on orchard trees. Several species of cutworms even less occasionally climb the trees and feed on the leaves or fruit.

Injury

Green fruitworms feed on the leaves but are not likely to be numerous



Green fruitworm injury.

enough to cause severe damage by feeding. When they attack the fruit they eat deep holes about the size of the thickness of a lead pencil. The injured fruit either drops early or is deformed.

Control

The regular sprays of lead arsenate or DDT in the calyx spray usually give sufficient control. If any of this group of pests are present in large numbers, add DDT or lead arsenate to the pre-pink or pink spray as given under the discussion of tent caterpillars.

CATERPILLARS of OCCASIONAL IMPORTANCE

There are several other caterpillars that occasionally become numerous enough to attract attention or to cause damage on the apple or pear. Most of



Apple and thorn skeletonizer injury.

these are well controlled by the regular spray program and are thus more likely to be seen on young trees that have not been well sprayed. A few are given here mainly for reference.

Apple and Thorn Skeletonizer, *Anthophila pariana* (Clerck)

These insects are often conspicuous on young fruit trees which have received only limited poison sprays. The larvae are small, spotted caterpillars that feed

on the upper side of the leaf, eating all but the veins and lower surface. They roll the edges of the leaf upwards and fasten them with a web under which they feed. There are two broods a year, with injury occurring in July and again in late August and September.

They may attack apple, plum, quince, and hawthorn. The ornamental crab is very subject to attack.

Lead arsenate, calcium arsenate, and DDT are all very effective against them when used at rates recommended for tent caterpillars.

Fall Webworm, *Hyphantria cunea* Drury

The fall webworms form large webs sometimes a yard long on fruit trees and various shade and forest trees. These webs are formed in August and thus can be easily distinguished from the "tents" of the tent caterpillar which are formed in the spring. The caterpillars that feed in the web are very hairy. The adults are white moths with a one-inch wingspread.

These insects when present even in fairly small numbers are conspicuous. The injury they cause is not likely to be important.

The poisons recommended for tent caterpillars will control them.

Red-humped Caterpillar, *Schizura concinna* (A. & S.)

Yellow-necked Caterpillar, *Datana ministra* (Drury)

In August and September, black and yellow caterpillars with either a red hump on the back towards the head end or with a yellow ring back of the head may occur on the apple, pear, and other fruit trees, and also on shade trees. They hatch from a cluster of eggs and the larvae feed in clusters on the leaves.

Injury is not likely to be important except that occasionally they may defoliate an unprotected young tree.

Sprays recommended for tent caterpillars are effective in controlling them.

TENTIFORM LEAF MINER

Ornix geminatella (Packard)

Small moths the size of clothes moths lay eggs on the leaves from which small larvae hatch that feed between the upper and lower epidermis of the leaf in the manner of a leaf miner. The mines they cause are very characteristic in size and shape. The upper epidermis of the leaf over the mine is always raised slightly above the rest of the leaf, thus this insect derives its common name "tentiform".

Usually there are very few such leaves in an orchard, but occasionally many are found with some leaves having more than one mine. Since the amount of the leaf surface injured is small, injury is not usually considered important but not all entomologists agree with this.

The author does not think it is economic to apply sprays against them.



Characteristic “mines” caused by tentiform leaf miner.

The effectiveness of materials against this insect is not well known but parathion and TEPP are likely to be satisfactory.

OYSTERSHELL SCALE

Lepidosaphes ulmi (L.)

The oystershell scale is about one-eighth of an inch long and is three times as long as broad. It tapers to one end and resembles somewhat the shell of an oyster. The colour is similar to the bark of the tree.

This scale is common in all parts of the Province and was very injurious in some orchards about 1947 and 1948. It may be troublesome in a few orchards, particularly on Spy.

Oystershell scale may attack any fruit tree and many shade trees and shrubs.

Injury

When heavily attacked a tree will be weakened and unable to produce profitable crops. Very heavily infested limbs may die. If the infestation is severe, scales will be found on the fruit and the stems of the leaves.

Life History

This pest winters in the egg stage under the scales in each of which there



Adults and "crawlers" (young) of oystershell scale on bark in June (greatly enlarged).

are 30 to 40 white eggs. The eggs start hatching about calyx time and continue for 10 days. The tiny, white or cream-coloured young, or "crawlers", move around on the bark for about a day and then settle and work their slender, bristle-like mouthparts through the bark. Gradually wax coverings develop over their bodies forming the scales. The females when full-grown lay their eggs in August and then die. There is one brood a year.

Control

Apply control either as a dormant spray or during the first part of June when the eggs are hatching.

(a) Dormant spray. Use either a 1% spray of 40% dinitro cresol paste (4 Imperial quarts of Elgetol, Dinitrosol, or Krenite in 100 gallons of water) or a 5% dormant oil emulsion.

(b) Calyx and first cover spray. Use 50% DDT wettable powder 2 pounds in 100 gallons of spray in the calyx and first cover spray. The DDT kills the "crawlers" the day after hatching when they are moving on the bark of the tree. Therefore, be sure to apply the first DDT spray before any young have settled on the bark.

LECANIUM SCALE *Lecanium corni* Bouché

This is a large, brown, convex scale usually found on the underside of the twig. This scale shows a preference for certain varieties. In Ontario the Spy

has been the most frequently attacked. It has also been found on Wealthy, Transparent, Baldwin, Astrachan, Wolf River, and Alexander. It also attacks other fruit trees, such as plum, prune, peach, cherry, and grape, many shade trees, and some evergreens.

This scale is illustrated on page 28.

Injury

The scales suck the sap from the leaves during late July and August and from the twigs during May and June of the following year. The leaves and fruit become sooty-black from a black fungus that develops in the honeydew secreted by these scales.

Life History

There is one brood a year. They overwinter as immature, small scales on the twigs. Some of the old, large, dead scales may be present also on the twigs during the winter. The overwintering young develop in May and June to large, brown scales at which time the females have matured the eggs. The females die, leaving the scales filled with eggs which hatch in July, and young, or "crawlers", move to the undersides of the leaves where they settle and feed until fall. Then they crawl back to the undersides of the twigs for winter.

Control

Apply a dormant oil spray or use parathion or malathion in July. Spray with one of the following:

(a) Dormant spray. Use 4% dormant oil emulsion in the delayed dormant bordeaux spray.

(b) Parathion in July. Use 15% parathion wettable powder 1½ pounds in 100 gallons of spray at the time of the full hatch of the scale. This will be from about July 10 to 15.

(c) Malathion in July. Use 25% malathion wettable powder 2 pounds in 100 gallons of spray and make two applications about 10 days apart starting when 50 per cent of the eggs have hatched.

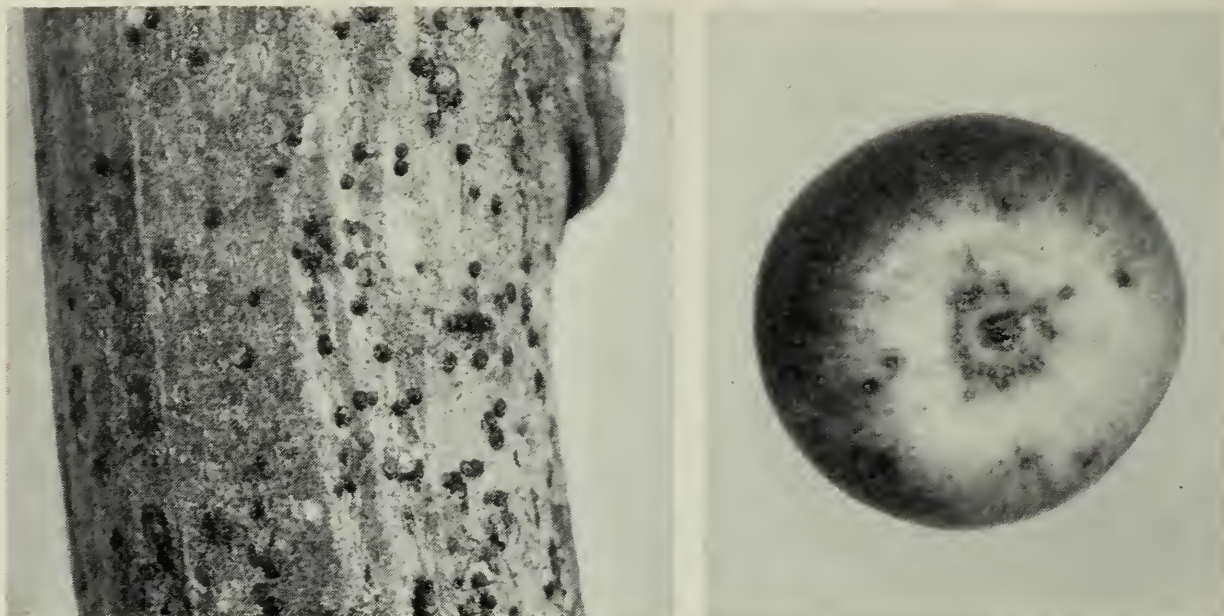
The exact time to apply the parathion and malathion sprays will be given each year by spray service letter.

SAN JOSE SCALE

Aspidiotus perniciosus Comst.

San José scale at one time was one of the most important insects on the apple and pear, but very few apple and pear orchards are infested now. Since trees heavily infested with this scale may be killed, it is hoped it will not return in destructive numbers.

This is the smallest of the common types of scales being about the diameter of a pin head. It is nearly flat, circular, ashy-brown in colour with a central area raised in a pimple-like manner. The winter scale is similar in form but is smaller and black.



San José scale on bark (greatly enlarged) and fruit.

Hosts of this scale are almost all fruit trees and bushes and many shade trees and shrubs, such as mountain ash, hawthorn, Japanese quince, and rose. The Keiffer pear seems to be nearly immune.

Injury

Heavily attacked trees are greatly weakened and limbs or the whole plant may be killed. If the scale attacks the fruit a reddish ring develops in the skin around the place where it settles down. Most of the scales will be found around the calyx end of the fruit.

Life History

These insects spend the winter on the bark as immature, small, black scales which develop to adults by June. By the end of June the females give birth to light-coloured young which move around for a day and then settle on the bark, leaves, and fruits, inject their mouthparts, and immediately secrete the scale covering. They feed there without moving until mature. A second or third brood may develop before fall.

This scale develops only in the warmer parts of Ontario.

Control

Dormant and delayed dormant sprays have been the most effective of the materials well tested against this scale. Use one of the following:

- (a) Dormant spray. Lime sulphur 1 gallon in 8 gallons of water.
- (b) Delayed dormant. Add 4% dormant oil emulsion to the delayed dormant bordeaux.

SHOT-HOLE BORER

Scolytus rugulosus (Ratz.)

The adult is a reddish-black beetle about one-tenth of an inch long. The larva is a small, white grub found under the bark.

This pest is not often important on apple and pear except where there are many dead or dying limbs or trees. Injury may occur near brush piles or where stove wood is piled in or near the orchard. It attacks the stone fruits more readily than apple and pear.

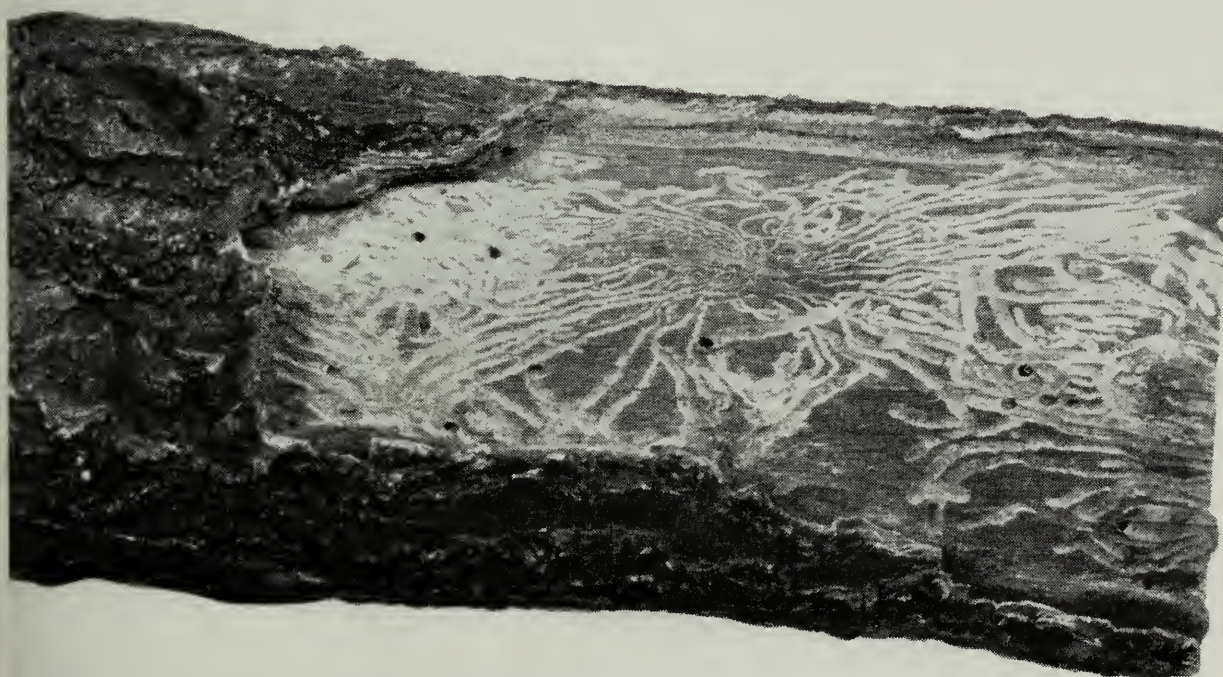
Injury

Dead or dying limbs and weak trees are attacked first. If heavy infestations are present, healthy trees will also be injured. The beetles make shot-like holes in the bark often at the base of the buds or spurs. Both the beetles and grubs make channels, known as "galleries", in the area just under the bark. If series of channels completely circle the limb, it dies.

Life History

The grubs spend the winter in their burrows under the bark. These pupate in the spring and emerge through shot-hole openings in the bark in June. After mating, the females eat small holes through the bark and under them they make channels along which the eggs are laid. Upon hatching, the grubs feed generally at right angles to the channel. These pupate when mature and the new beetles

Bark partly removed to show shot-hole borer injury. "Shot-holes" in bark are also shown.



emerge in late August and September and repeat the same operation. There are two broods a year.

Control

- (1) Prune and burn all dead or dying wood before June 1.
- (2) Burn or remove from the vicinity of the orchard any fruit-tree or other wood before June 1.
- (3) If the beetles attack the buds of young trees spray with 50% DDT wettable powder 2 pounds in 100 gallons of spray.

APPLE FLEA WEEVIL *Rhynchaenus pallicornis* (Say)

The apple flea weevil is a very small, dull-black snout beetle about one-tenth of an inch long. The adult weevils puncture the opening leaves and buds of apples in the spring. The injury to the leaves is similar to that made by fine birdshot.

This insect has been present only in a small area in Norfolk county. It may be found also on hawthorn, quince, wild crab, and blackberry.

The regular sprays normally keep this pest under control. Where special sprays are required, use lead arsenate 4 pounds or 50% DDT wettable powder 2 pounds in 100 gallons of spray.



Rose chafers feeding on the fruit.

ROSE CHAFER

Macrodactylus subspinosus (F.)

The rose chafer is a pest of minor importance in apple and pear orchards but occasionally it may cause trouble in sandy soil areas.

The adult is a long-legged, fawn-coloured beetle about half an inch long that appears in orchards about the middle of June. The adult beetles feed on the leaves or they may eat gouges in the small fruit. They attack a great many other plants with greater relish than the apple and pear.

DDT in the regular codling moth sprays usually gives sufficient control. If extra sprays are required, apply 50% DDT wettable powder 2 pounds in 100 gallons of spray.

APPLE SEED CHALCID

Torymus druparum Boh.

The adult is a tiny, four-winged, dark-coloured, wasp-like insect with the head, thorax, and abdomen green. The larva develops in the seed of the apple.

The apple seed chalcid is generally distributed in Ontario but is seldom found in commercial varieties except crab apples or very small apples of large-fruited varieties. It has been found in Russet, Spy, and Baldwin and so may occur in small fruits of other standard varieties. It attacks wild apples and ornamental crabs.

Injury

The larvae develop in the seeds and thus cause no damage. The only external visible evidence is a small, shallow dimple, similar to an apple-maggot-fly puncture, in the skin where it was punctured during egg laying. A discoloured line extends from this directly to the seed. This will distinguish it from the apple maggot, which forms brown irregular streaks in the flesh of the apple.

Life History

The important habit of this insect is that of attacking small apples only. In large apples the females are unable to reach the seeds in order to deposit their eggs.

Control

It is advisable not to grow ornamental crabs near the apple orchard. Remove wild apples within 600 yards of the orchard.

This insect is included in this bulletin primarily to give information that will help distinguish the apple seed chalcid from the apple maggot, especially where an orchard is under apple maggot certification.



Buffalo treehopper on twig and scars caused by egg laying.

BUFFALO TREEHOPPER

Ceresa bubalis (F.)

The adult treehopper is about three-eighths of an inch long, triangular, and greenish in colour. The two upper angles of the thorax project thus suggesting the name "buffalo".

This pest is important in all parts of Ontario when new apple and pear orchards are being established. It attacks all other fruit trees, and also shade trees and shrubs.

Injury

Severely damaged young apple and pear trees take several years longer to develop or, if severe attacks continue, may not develop satisfactorily. The damage is caused by the females which, during egg laying, make slits in the bark and deposit two rows of eggs a short distance apart in the wood under the slits. The wood between these rows does not heal thus scars develop which continue to enlarge for several years. Heavily injured trees may be more susceptible to severe winters and disease.

Life History

They spend the winter as eggs in the slits in the bark. The nymphs hatch about the first week in June and drop to the ground where they feed particularly on alfalfa, weeds, clover, and other plants. The nymphs are curious, spiny insects that are seldom seen. They change to adults the end of July with egg laying taking place in August and September. There is one brood a year.

Control

(1) Clean cultivation up to the end of June will control them. By this method the nymphs are starved when they drop from the trees. Do not use alfalfa as a cover crop.

(2) If it is not advisable to clean cultivate, which may be the case where orchards are on steep slopes, spray the trees, cover crop, weeds, and the fence rows along the orchard with 50% DDT wettable powder 3 pounds in 100 gallons of spray. Apply the spray about August 1 in the Niagara Peninsula and Essex and Kent counties, and about August 10 in other areas of Ontario.

ROUNDHEADED APPLE TREE BORER

Saperda candida F.

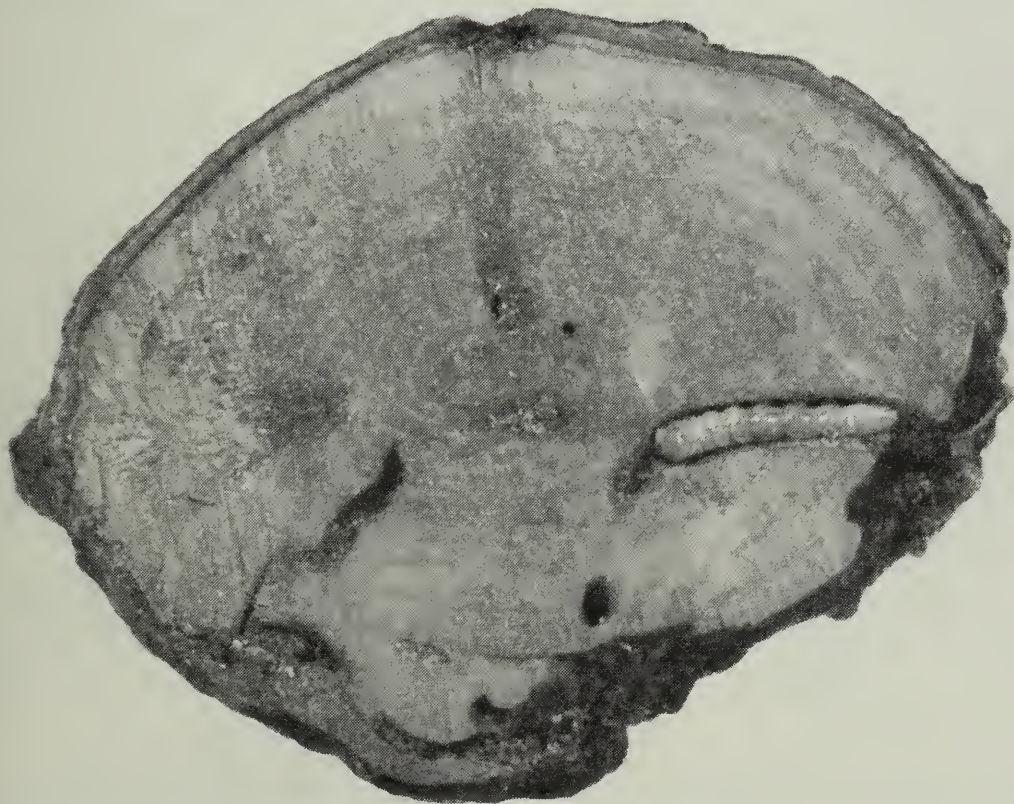
The adult of this insect is a large, attractive beetle with two white bands that extend along the back the entire length of the insect. The larva, which causes the injury, is a stout, nearly cylindrical, whitish grub about an inch long when full-grown; the head is brown and the body is largest immediately behind the head.

This insect is important in a few orchards only, particularly where other host trees are in the fence row or near the orchard, such as hawthorn, choke cherry, and mountain ash.

Injury

The larvae, or borers, work in the trunk near the ground or a short distance below it. Trees of any age may be attacked but the greatest damage occurs on

The larva and injury caused by the roundheaded apple tree borer.



those from one to ten years of age. Small trees may be injured to such an extent that they break over.

Life History

These insects winter as larvae in the trunk of the tree. The beetles emerge in May and June and lay eggs on the bark near the ground for a period of one to two months. On hatching, the borers work into the bark and wood of the tree. These feed as borers for two or three years, pupate in the spring of the second or third year, and emerge as adults. They take either two or three years to complete the life cycle.

Control

(1) Remove mountain ash, choke cherry, hawthorn, and wild apple within 600 yards of the orchard.

(2) Lead arsenate at 3 or 4 pounds to 100 gallons applied in the regular sprays through June and July kills many of the beetles and thus reduces infestations. These sprays used with Control (1) are usually all that are required for the control of this pest. Although not specifically tested, DDT is likely to be similar in control to lead arsenate.

(3) Dig them out with a knife or flexible wire in late August or early September and, if any are missed at that time, go over the trees again in late April.

(4) In place of Control (3) inject into the burrows about one cubic centimeter of one of the following mixtures using an oil can or syringe: (a) Ten ounces of paradichlorobenzene dissolved in half a pint of carbon bisulphide; (b) Five per cent rotenone extract in acetone; or (c) Pyrethrum extract in alcohol.

(5) As a repellent to prevent egg laying, apply a paint of white lead and linseed oil (not turpentine) to the lower part of the trunk of the tree in late May.

INSECTS of the PEAR

PEAR PSYLLA

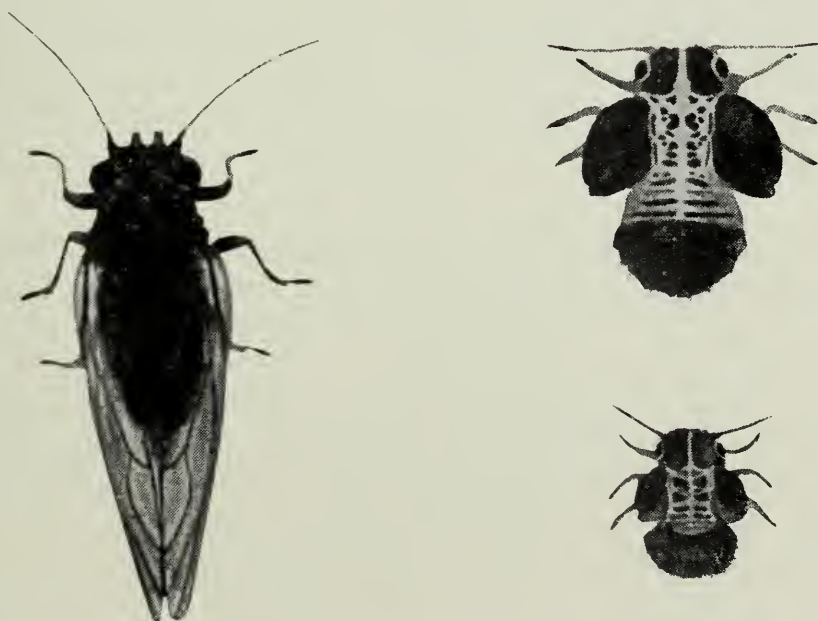
Psylla pyricola Foerst.

The pear psylla is the most important insect attacking the pear in most districts of Ontario. The infestations vary from year to year. Usually hot weather just before and during the blossom period results in a heavy infestation during the early part of the season. It is more destructive in the southern areas of the Province.

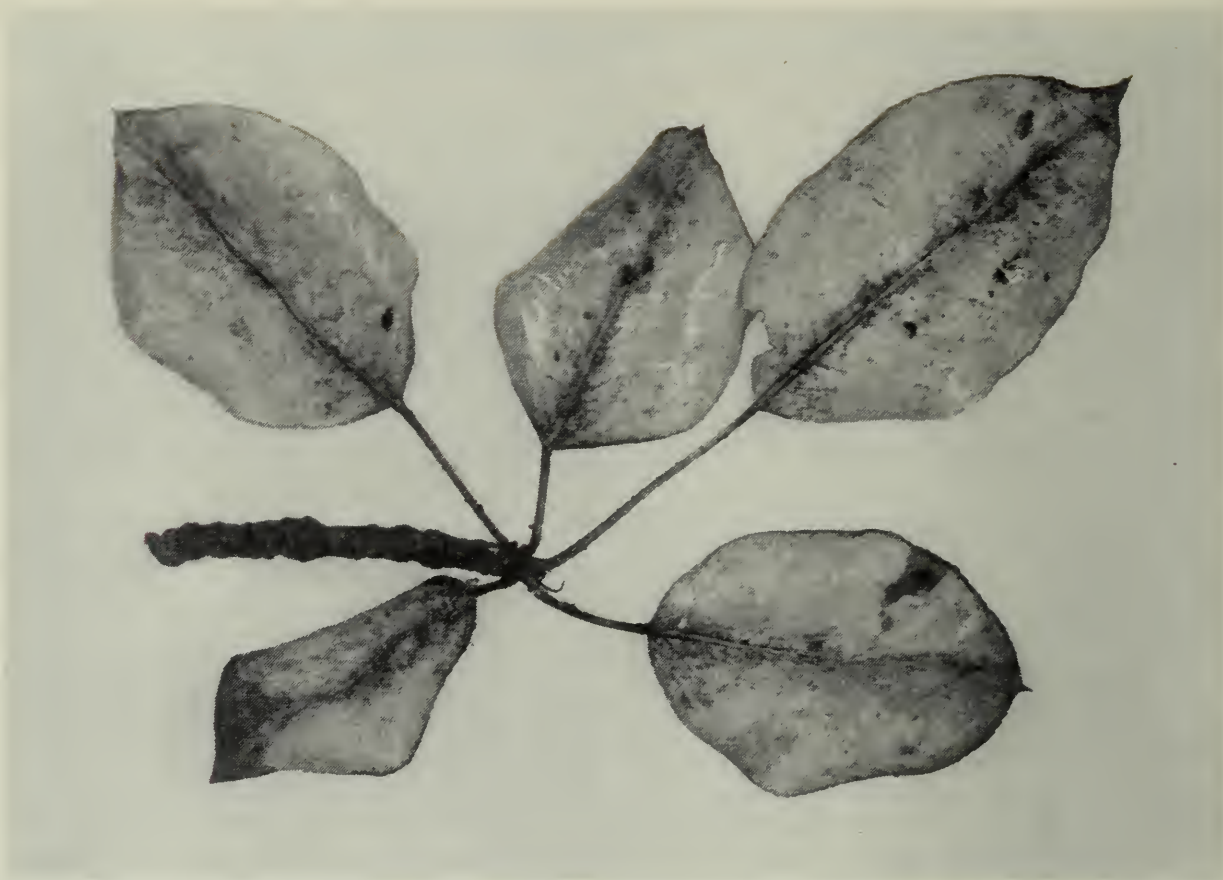
The adult pear psylla is a small insect about the size of a winged aphid. With the aid of a hand lens it will be found to resemble a diminutive cicada. The hind legs are adapted for jumping and the adults, when disturbed, quickly jump and fly away.

The nymph, or immature stage, is unlike the adult, being sluggish and remaining in one place for a long time. At first it is pale-yellow with red eyes, but when nearly full-grown it darkens and changes to a brown colour with conspicuous broad pads at each side which, in the adult, become the wings. All stages of the nymphs are broad, flattened, and oval in outline. The nymphs are found on both the top and bottom of the leaves enveloped in a sticky substance known as honeydew. These shiny, liquid spots on the leaves when the foliage normally would be dry help identify an infestation.

This insect attacks the pear only.



Pear psylla adult at left, nymphs (young) at right, all greatly enlarged (Courtesy Science Service, Can. Dept. Agr.).



Pear psylla injury and the sooty fungus which follows psylla infestations.

Injury

Both the adults and nymphs suck the juice from the leaves, leaf and fruit stems, and tender new growth. Trees heavily attacked have a weakened vitality, dwarfed fruit, pale foliage, and large dead areas in the leaves. Heavy attacks in August may cause premature defoliation. In addition the leaves, fruit, and branches become stained with a black fungus that grows in the honeydew secreted by the psylla. The fungus on the fruit is shown on page 28. The ill effect of a heavy psylla attack is not limited to one year but extends over into the following year or longer causing smaller crops or even crop failure.

Life History

These insects spend the winter as adults in crevices in the trees, under loose bark, grass, leaves, or rubbish beneath the trees. In the spring on bright sunny days near the end of March or in April, they fly to the trees where, after several warm days, they lay their eggs on the twigs and fruit spurs near the buds. They are among the first fruit insects to move to the trees and lay eggs in the spring. Egg laying of the adults that wintered over may continue until the blossoms have fallen. The first eggs hatch when the fruit buds burst and nearly all of this group have hatched in a season of normal temperature by the time the blossoms have fallen. The newly hatched nymphs feed on the blossom and leaf parts and later on the leaves and new growth. There are two complete, a large partial third, and a small partial fourth generation a year depending on the season. When cold weather comes in the fall, the adults go to winter quarters.

Control

Control may be obtained by the application of a dormant oil spray very early in the spring to prevent egg laying plus midsummer organic phosphate sprays, or by the use of organic phosphates starting at calyx time. Use one of the following:

(1) Dormant oil. Apply 3% dormant oil emulsion early in the spring, that is, in March or April, before eggs are laid. The oil spray kills some adults during application and the psyllas are repelled from laying eggs on the oily twigs. It does not kill the eggs and therefore is ineffective if applied late. Use also malathion or parathion about July 7 and August 1 at the same rate as recommended in Control (2).

The dormant oil method is being replaced largely by a full summer schedule of malathion or parathion because often either the orchard ground is too soft to carry the sprayer or the weather is too windy or wet for spraying in late March or early April.

(2) Summer sprays. The phosphate insecticides such as malathion and parathion are effective against the nymphs and adults but not the eggs, thus several applications may be required. Apply the first spray when all the eggs laid by the overwintering adults have hatched, that is, about calyx stage. Apply the second and third sprays about July 7 and August 1. Use either 25% malathion wettable powder 2 pounds or 15% parathion wettable powder 1 pound in 100 gallons of spray. If infestations occur between or after any of these applications, spray again.

Follow instructions given by your local Spray Service each year for accurate timing of all psylla sprays.

PEAR LEAF BLISTER MITE

Eriophyes pyri (Pgst.)

The pear leaf blister mite is found throughout Ontario. It is proportionately more prevalent on home plantings but occasionally commercial orchards become heavily infested.

This pest is a mite so small that it can be seen only with the aid of a lens. Identification may be more easily made by the characteristic blisters on the leaves.

It attacks the pear, apple, mountain ash, and related trees, with the pear being the favoured host.

Injury

The injury is done almost entirely to the foliage, where the mites cause numerous little blisters on the undersides. The infested portion of the leaf soon dies, and thus if there are large numbers of mites, a large part of each leaf will be killed and the vigour of the tree affected. The mites may attack the fruit and fruit stems early in the season causing small blisters which later disappear without leaving any visible effect.



Pear leaf blister mite on apple and pear leaves.

Life History

They spend the winter as adults under the bud scales. After the buds burst in the spring they move about and soon work their way through the lower epidermis of the leaf where they feed and cause small blisters in which eggs are laid. The mature young from these eggs move out to form new blisters in the leaf. There are several generations a year. Before the leaves fall in October they go to winter quarters beneath the bud scales.

There are no winged forms. This accounts for the fact that some trees or even parts of trees often become heavily infested before the rest of the orchard.

Control

Where trees are known to be infested, apply a dormant spray of lime sulphur 1 to 10, that is, add 10 gallons of lime sulphur to the spray tank and fill with water to 100 gallons. One very thorough application will almost eliminate this pest and thus treatment is not required every year.

The 3% dormant oil spray which is given in the discussion of pear psylla helps control the blister mite. If a more specific combination dormant spray for both psylla and blister mite is desired, add 10 gallons of lime sulphur to 100 gallons of 3% dormant oil emulsion.

During budding or grafting, obtain scions or bud sticks from trees free from this mite.

PEAR-SLUG

Caliroa cerasi (L.)

The pear-slug is an insect that is very plentiful some years and unimportant at other times. It is likely to be more prevalent on young trees or trees that do not receive all recommended sprays.

The adult is a four-winged, black and yellow sawfly, a little larger than a house fly. The larva—the injurious stage—is slimy, blackish or greenish-black, about half an inch long, and enlarged toward the front. It has the appearance of a small, black slug because it is covered with slime.

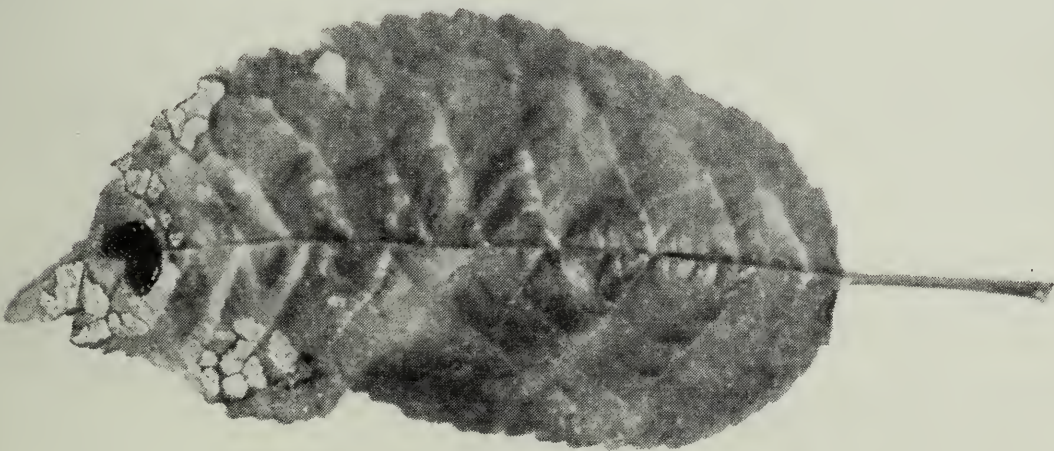
This pest attacks cherry, pear, and plum, cherry being the preferred host.

Injury

The larvae eat the tops of the leaves, leaving only a network of veins and the lower epidermis. The injured areas soon die. When very abundant they eat the surface of the fruit too, leaving a russeted appearance. Trees severely attacked lose vigour, especially if injured in two successive years.

Life History

The pear-slugs spend the winter as full-grown larvae in earthen cases in the ground. They pupate in these cases in the spring, the adults emerging after petal fall on pears. The adults lay eggs in the leaf tissue. About the middle of June the tiny “slugs” hatch and feed on the upper surface of the leaf. When mature these drop to the ground and form small earthen cases. Some of these remain as larvae in the cases until the next spring while others pupate and emerge to form a partial second brood. Thus there are about one and one-half broods a year.



Pear-slug and injury.

Control

This insect is easy to control because nearly all the insecticides are effective against it. Bearing trees that receive all the sprays necessary to protect the fruit and leaves from other pests are not likely to require special sprays for pear-slug. If special sprays are required either on bearing or young trees, use 50% DDT wettable powder 2 pounds or lead arsenate 3 pounds in 100 gallons of spray.

PLANT BUGS

Several species of plant bugs, in addition to tarnished plant bug described previously in the discussion of apple insects, may attack the pear. The importance of this group varies from orchard to orchard and from year to year. Occasionally there is severe damage in individual orchards.

Injury

The nymphs and later the adults puncture the young pears during feeding. The area surrounding the puncture fails to grow properly with the result that the pears have depressed, russeted areas or may be knotty, deformed, or goose-necked. This injury is illustrated on the cover. Hard tissue extends in from the injury usually to the core.

Life History

The tarnished plant bug overwinters as an adult while some of the other species overwinter in the egg stage. The development through the winter is described in the apple insect section.

Control

In pear orchards where plant bugs have caused damage in previous years or as a preventive measure in any orchard, apply 50% DDT wettable powder 2 pounds in 100 gallons of spray as soon as the petals have fallen. If at any time after petal fall there is a migration of plant bugs to the trees as a result of mowing the cover crop or cutting hay in adjacent fields, make another application of DDT as above.

Control weeds, shrubs, and particularly wild or uncared-for fruit trees in and near the pear orchard.

CODLING MOTH

Carpocapsa pomonella (L.)

The codling moth, while not so injurious on pear as on apple, is one of the most important pests of this fruit, particularly on Bartlett.

The life history and injury on pear are essentially the same as those described for the codling moth in the apple insect section except that in some

large pear orchards a strain has developed whose spring brood of moths emerges from two to three weeks later than the apple-infesting strain. This results in a comparatively very small, unimportant second brood. Injury is likely to be more severe in hot, dry seasons.

Control

Apply a spray of lead arsenate 4 pounds in 100 gallons of spray soon after the petals fall, followed by two sprays of 50% DDT wettable powder 2 pounds in 100 gallons of spray about July 7 and August 1. Follow the recommendations in spray service letters concerning an additional application for seasons when a heavy attack is expected.

ORIENTAL FRUIT MOTH

Grapholitha molesta (Busck)

The Oriental fruit moth occasionally attacks pears in areas where peaches are grown. A brief account related to pear infestation only is included here because bulletins on stone-fruit insects give details of this pest.

Injury to Pear

Infested fruit has a larva, or "worm", similar in appearance to a codling



Fruit tree leaf roller injury.

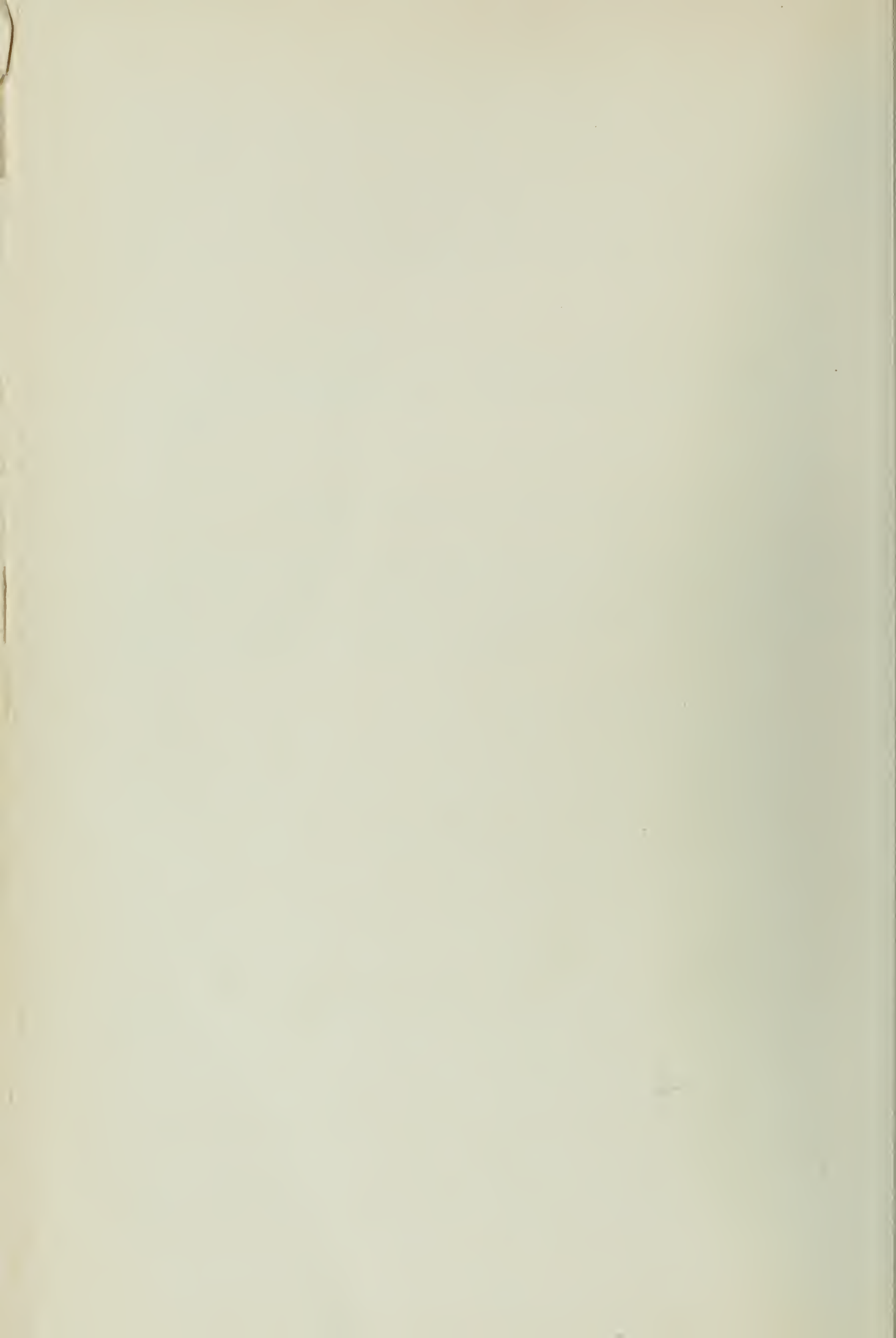
moth, near the core but typically shows no, or almost no, sign of external injury. Kieffer pears, and more rarely Anjou, are the only varieties subject to attack and these are subject only where high temperatures occur in late September after peaches have been harvested. The moths leave the peach orchards and fly to pear trees where many eggs may be laid which will hatch if warm weather follows. The severity of attack is influenced also by the time moths are at peak abundance, which varies from year to year. The exact conditions necessary to bring about fruit moth infestations in pears have occurred only twice in the last 10 years.

Control

A spray of 50% DDT wettable powder 2 pounds in 100 gallons of spray applied three weeks before harvesting Kieffer pears will give good control. Follow your regional Spray Service for information on seasons when treatment is required.

OTHER INSECTS that ATTACK the PEAR

In addition to the specific insects given previously, almost all the insects and mites that attack the apple also attack the pear. The apple maggot is an exception. Generally the insects and mites are not so difficult to control on pear with the exceptions being fruit tree leaf roller, leaf-eating insects, oystershell scale, San José scale, and buffalo treehopper.



CARONAF6
B513

THE STRAWBERRY IN ONTARIO

HORTICULTURAL EXPERIMENT STATION

VINELAND STATION, ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

	PAGE
SOME PRODUCTION FIGURES	3
VARIETIES — IN GENERAL	4
Climatic Adaptation, Virus Disease, Plant Stand.	
VARIETIES — DESCRIPTIVE NOTES	5
RECOMMENDED VARIETIES	9
POLLINATION	10
LOCATION AND SITE	10
SOILS	10
SOIL PREPARATION AND FERTILIZATION	11
Organic Matter — Manure, Hay and Straw, Green-manure	
Crops — Fertilizer, Soil Reaction, Working the Land.	
ROTATION OF STRAWBERRIES	13
DIGGING PLANTS	13
PLANTING	14
Systems of Planting, Distance of Planting, Number of Plants per	
Acre, Selection of Plants, Time of Planting and Cold Storage,	
Setting the Plants, Machine Planting.	
CARE OF YOUNG PLANTATION	19
Cultivation and Weeding, Chemical Weed Control, Weeding with	
Geese, Blossom Removal, Thinning and Spacing.	
MULCHING	21
Reasons for Mulching, Time of Application, Materials to Use,	
Mulch Removal.	
FROST INJURY	23
IRRIGATION	23
PICKING AND PACKING	24
RENEWAL OF THE PLANTATION	25
YIELDS AND RETURNS	26
EVERBEARING STRAWBERRIES	26
INSECTS AND MITES OF THE STRAWBERRY	29
Strawberry Leaf Roller, Spittle Bugs, Two-Spotted Spider Mite,	
White Grubs, Strawberry Weevil, Strawberry Leaf Beetle,	
Cyclamen Mite, Cutworms.	
STRAWBERRY DISEASES	34
Black Root (Root Rot), Grey Mould, Red Stele, Verticillium	
Wilt, June Yellows, Powdery Mildew, Leaf Spot, Leaf Scorch,	
Leaf Blight, Virus Diseases.	

THE STRAWBERRY IN ONTARIO

J. F. BROWN

The strawberry is an important fruit crop in Canada. It is second only to the apple in crop value for Canada as a whole. Strawberries are grown from coast to coast with commercial production centred chiefly in British Columbia, Ontario, Quebec and to a lesser extent in the Maritimes.

SOME PRODUCTION FIGURES

Table 1 shows the average annual crop and its value for the period 1950-54 in the main producing areas.

Table 1. Strawberry Production in Canada*

	Average Annual Crop for Period, 1950-54	Average Annual Value for Period, 1950-54
	Quarts	Dollars
Prince Edward Island.....	720,000	116,000
Nova Scotia.....	901,000	195,000
New Brunswick.....	887,000	179,000
Quebec.....	6,200,000	1,604,000
Ontario.....	9,105,000	1,932,000
British Columbia.....	10,711,000	2,579,000
TOTAL, CANADA	28,244,000	6,358,000

* Figures adapted from Reports of Marketing Service, Canada Department of Agriculture.

In Ontario the strawberry ranks fourth among fruit crops in total value — behind apples, peaches, and grapes. For the purpose of crop statistics, Ontario is divided into two areas — east of Toronto and west of Toronto. Recent strawberry production figures on this basis are presented in Table 2.

Table 2. Strawberry Production in Ontario*

	Average Annual Acreage for Period, 1950-54	Production for 1955	Average Annual Production for Period, 1950-54
	Acres	Quarts	Quarts
East of Toronto.....	945	915,875	1,447,200
West of Toronto.....	2,880	7,652,570	7,658,700
TOTAL, ONTARIO.....	3,825	8,568,445	9,105,900

* Figures adapted from Reports of Statistics and Publications Branch, Ontario Department of Agriculture.

Strawberry acreage in Ontario since 1945 has ranged from a low of 3,196 acres in 1946 to a high of 4,052 acres in 1952. Total production has ranged from a low of 5,349,000 quarts in 1949 (a very dry season) to a high of 10,069,000 quarts in 1948.

With regard to distribution of strawberry acreage in Ontario in recent years, approximately one-quarter has been grown in Norfolk county, one-

quarter in the Niagara district, one-quarter east of Toronto. The remaining one-quarter has been distributed over Western Ontario mainly in the Toronto-Hamilton district, Georgian Bay area, Elgin-Oxford counties, and Brant county.

The close proximity of New York and Michigan to Ontario makes it of interest to note that, in comparison to Ontario's acreage of 4,086 in 1955, New York State reports 4,100 and Michigan 11,000 acres.

VARIETIES—IN GENERAL

What varieties should you plant? For your main planting, use only the varieties that are being grown successfully in your area. They are the ones that are adapted to local conditions of soil and climate.

At the same time, other promising sorts should be tried because they may prove superior in one or more ways. The Horticultural Experiment Station at Vineland and the Central Experimental Farm at Ottawa and Smithfield carry on continuous variety trials. The results are available to you in the Provincial and Dominion Bulletins and from your district Horticultural Fieldman. In deciding what other varieties to try, you may be guided in part by the results of these trials but there are a few points to keep in mind as follows.

Climatic Adaptation

Strawberry varieties are adapted to certain regions because of climatic conditions. The need for a winter rest or the ability to do without it, the response to long or short days, and the response to hot or cool summers are the factors that largely determine the suitability of a variety to a given area.

Missionary and Florida 90 need very little winter cold to break their rest so they grow well in Florida but not farther north. Shasta, Lassen, and Sierra are well adapted to central California conditions but are useless in the east. Premier does well throughout the whole northeast but is not grown to any extent west of Minnesota or south of Pennsylvania. Northwest and British Sovereign are grown on the Pacific Coast but not elsewhere.

You should test only varieties that originate in the northeast or have been shown to be adapted here. The testing of varieties from the deep south or far west is likely to be a waste of time.

Virus Disease

All strawberry varieties are susceptible to attack by virus diseases and in fact most of the stocks now being grown are infected to a greater or lesser extent. Unfortunately, most of the varieties grown in Ontario do not show visible symptoms when infected but performance is nevertheless affected. Some varieties suffer more than others from virus. For instance, Premier performs well unless heavily infected whereas Catskill suffers seriously from virus infection.

Recently the U.S. Department of Agriculture has made virus-free stocks of most common varieties available to U.S. nurseries. It is expected that Ontario nurseries will shortly be handling these plants. Experience with these stocks indicates that some older varieties such as Catskill may be worth growing again. Tests conducted in Canada and United States indicate that virus-free plants may yield almost twice as much fruit as the presently available stocks of infected plants.

In the future you should realize that virus infection of your own stocks of a particular variety may cause that variety to perform poorly for you. Where possible, virus-free stocks should be obtained and steps taken to keep virus out (see Page 38). If the virus-free stocks do not show to advantage, then it can be assumed that the variety is not adapted to local conditions.

Plant Stand

There is abundant evidence that the density of plant stand in a strawberry row markedly affects yield. If too many plants are present, yield is reduced because of crowding and competition for water and plant food. This has a bearing on variety testing in this way, some varieties naturally produce more runner plants than others. Some potentially good varieties are discarded by some growers because they have been allowed to fruit in too dense a row. Premier is not a prolific plant-maker and growers in Ontario set plants 18 inches apart and obtain rows that are, in general, not too crowded for good yields. However, Sparkle, Robinson and other varieties under the same conditions may set so many plants as to perform poorly. See Page 14 for further detail on thinning and spacing of strawberry rows.

VARIETIES—DESCRIPTIVE NOTES

All varieties in these descriptive notes are perfect-flowered with the exception of Louise, which is imperfect (see Page 7). The average ripening dates of the common varieties are given in the accompanying chart. In addition, see Page 9 for a list of recommended varieties.

Albritton — Introduced for the mid-south, not adapted to Ontario.

Blakemore — The leading variety in the mid-south, not suited to Ontario, being too vegetative and unproductive. Fruit blunt conic, medium size, light red, acid flavour and medium quality. Ships, freezes, and preserves well. Ripens about two days after Premier.

Catskill — This variety when virus-free, shows much promise for Ontario. Deserves extensive retrial using U.S.D.A. source of virus-free plants. Produces an abundance of large, sturdy, productive plants. Berries are unusually large, roundish wedge shape, bright medium red, good quality. Ripens about five days after Premier.

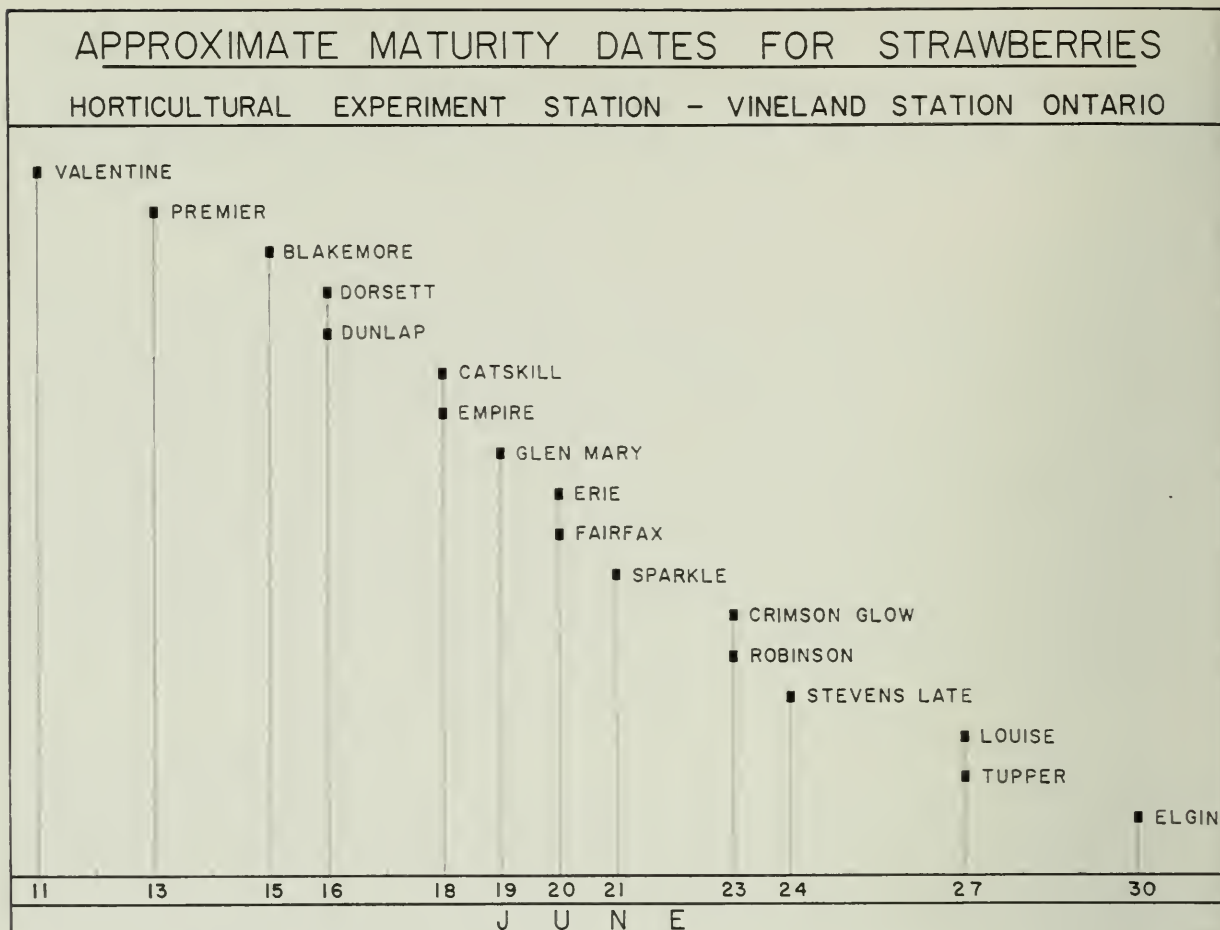
Crimson Glow — Usually too unproductive in Ontario. Runners freely, fruit medium to large, glossy dark red and good quality.

Culver — Introduced as a preserving variety, skin too tender for shipping, not grown in Ontario to any extent. Plants vigorous and productive. Fruit conical to wedge conical, glossy dark red, tart, good quality.

Dixieland — Well adapted to the same areas as Blakemore, does not perform well farther north.

Dorsett — Useful as high class dessert berry for select trade. Healthy plants runner freely necessitating plant thinning, not sufficiently productive. Fruit firm, bright red, very attractive and excellent quality.

Dresden — Not suited to Ontario, being too soft and too light in colour. Plants extremely abundant requiring excessive thinning to obtain good yields and size. Fruit quite soft, very light red, will not ship satisfactorily.



At Vineland, the average date for first picking of Valentine is June 11, for Premier June 13, etc., down to Louise, Tupper and Elgin, late varieties ripening their first fruits June 27, or 2 weeks after Valentine.

Dunlap (*Senator Dunlap*) — Not recommended for main strawberry areas, useful elsewhere because of its adaptability to heavier soil and varying climatic conditions. Prolific plant-maker, fruit tends to medium size, soft but fair quality, processes well.

Elgin — Useful as a very late variety for special markets. Many stocks now unproductive. Healthy stock runners and crops well. Fruit good size, light red, moderately firm and good quality. Ripens very late, about eighteen days after Premier.

Empire — A new variety from New York, well worthy of trial in Ontario. Plants vigorous and run well. Fruit large, conic to wedge conic, colour an attractive light glossy red, although internal colour is somewhat light. Skin tougher than Premier and quality better. Ripens about five days after Premier.

Erie — Also a new variety from New York, well worthy of trial in Ontario. Plant vigorous, producing plenty of runners. Fruit large, medium red, bright and attractive. Quality about same as Premier. Ripens about seven days after Premier.

Fairfax — Useful for select trade because of high quality. Chief fault is lack of crop. Plants large, vigorous from good stock. Fruit conic to wedge conic, dark attractive colour, good size early in season but tends to smallness later.

Fairland — Worthy of further trial in Ontario, may not be as productive as Premier, otherwise promising. Fruit large, glossy, medium red, good quality, attractive. Ripens four to six days after Premier.

Jerseybelle — Named spring of 1956 by the New Jersey Experiment Station. Not yet fruited in Ontario. Reputed to be a high yielder, making fewer plants than Sparkle and ripening after that variety. Fruit large, bright, shiny, firm, ships and freezes well.

Louise — Useful as a late variety, blossom imperfect so another late-blooming variety must be grown nearby. Fruit large, firm, meaty, bright glossy red, quality very good. Foliage quite susceptible to leaf spot disease.

Parson's Beauty (*Parson's*) — An old variety now superceded. Requires high fertility and good moisture to be productive. Fruit medium size, firm with fair quality but rather acid.

Pathfinder — Not sufficiently productive in Ontario. Good plant-maker, fruit bright colour, good size but quality only fair.

Pocahontas — A new origination from Maryland. Will fruit at Vineland in 1956. May be adapted to Ontario. Fruit is firm, bright red, with tough skin, large and moderately tart according to U.S. reports.

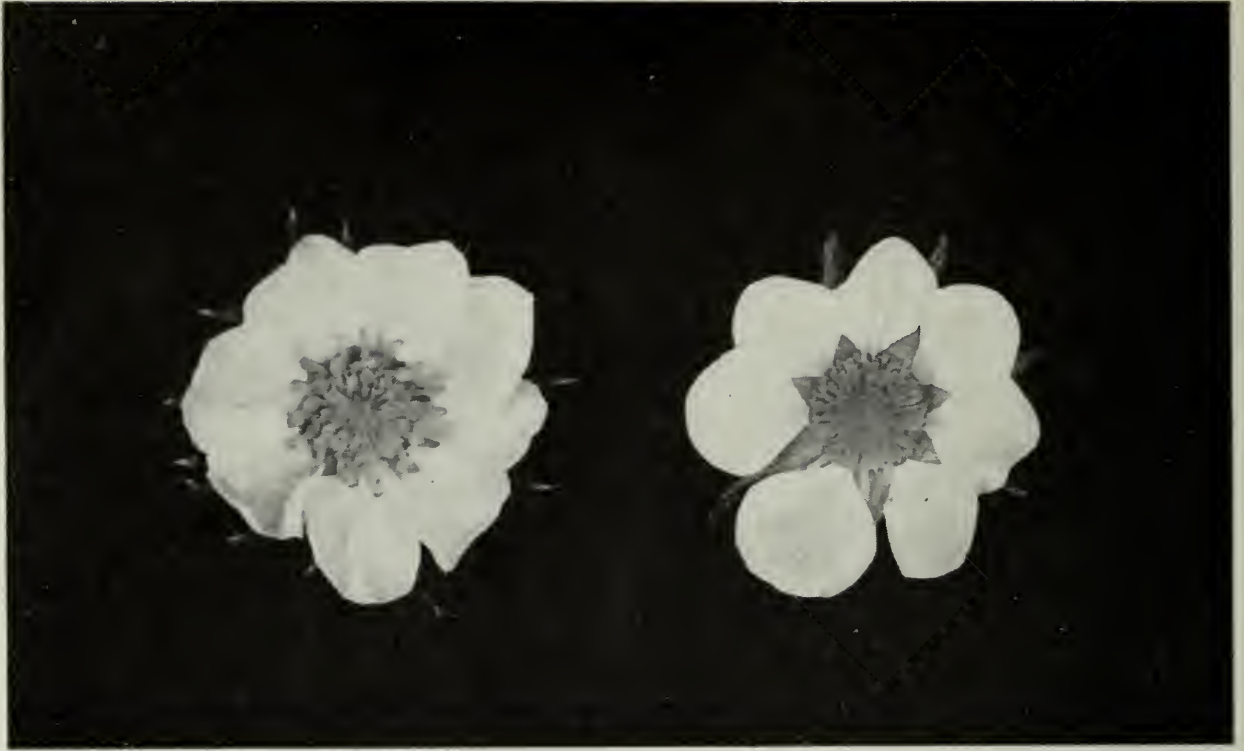
Premier (*Howard 17*) — The leading commercial variety in Ontario. A moderately good plant-maker, quite productive, well adapted to sandier soils in all parts of southern Ontario. Fruit large, conic to wedge conic, bright attractive red, good quality on warmer soils. Ontario stocks of plants only moderately virus-infected and still yield well. The virus-free stocks now available from U.S. sources are not true Premier in that the fruit is lighter in colour, softer, more acid, ripens later and shows fewer double berries. Premier is susceptible to the June Yellows disease which has become more prevalent in recent years (see Page 36).

Red Crop — From New Jersey, worthy of trial in Ontario. Produces an abundance of sturdy plants. Fruit blunt conic, very smooth, moderately firm, medium red colour, large size and heavy yielder and ripens a day or two after Premier.

Red Wing — Not satisfactory in Ontario. A good plant-maker, vigorous, not sufficiently productive, fruit medium to large, dark colour, not too firm. Ripens nine to ten days after Premier.

Robinson — Needs further trial in Ontario as a fresh-market berry, unacceptable as a processor. Now extensively grown in Michigan and finding increasing favour elsewhere in the Northeastern States because of high yields of large attractive fruit, and because it comes in when Premier is almost finished. Fruit is furrowed or ridged at sides and tends to green tips, bruises rather easily. This variety is a very prolific plant-maker and requires wider planting and some runner thinning to realize high yields and to get berry-size.

Sparkle — Virus-free stocks do very well in Ontario and should be tested more extensively. Produces more plants than Premier hence wider plant spacing and perhaps runner thinning is desirable. Fruit is large, very attractive bright glossy red, does not bruise easily, good quality and freezes well.



Perfect (left) and imperfect strawberry blooms. Perfect-flowered varieties are self-fruitful and may be planted in solid blocks of one variety. Imperfect-flowered varieties have no pollen of their own, and so require to be interplanted with a perfect variety to insure pollination.

Stelemaster — Introduced October 1954 by the U.S. Department of Agriculture because of resistance to all known races of red stele. Will fruit at Vineland in 1956 for the first time. Fruit medium size, smooth, uniform, firm, will not freeze satisfactorily according to U.S. reports.

Suwannee — Useful for home garden because of high quality, not productive enough for commercial use. Fruit medium to large, attractive, firm, good quality, mild and sweet.

Temple — Worthy of further trial in Ontario. Some growers do not find it productive enough, others are very pleased. Makes large vigorous plants. Fruit is large, blunt conic, attractive, medium red and good quality, quite firm, handles well.

"University" varieties — A general name applied to a group of varieties introduced by the University of California, including the varieties Shasta, Lassen, Sierra and Donner. Shasta and Lassen are now the leading varieties in California and ripen over a nine-month period. They behave as ordinary June-bearers in the east and are of little value.

Valentine — Introduced by the Horticultural Experiment Station because of its earliness, firmness and processing and freezing quality. Some stocks now unproductive presumably because of virus infection. Healthy stocks produce large robust plants in reasonable number. Fruit medium to large, dark glossy red, quite firm, fair to good quality, ships well. Still useful for earliness where vigorous stocks are used.

Vanrouge — Introduced by the Horticultural Experiment Station because of its very high quality as a freezing berry. Most stocks now lack vigour and



Trial plots of Vineland. Many new varieties of strawberries are being introduced. Those which may have value for Ontario conditions are given a thorough trial by Experiment Stations.

yield indifferently. Fruit is medium to large, dark glossy red, too dark if over-ripe, firm, good quality.

Vermillion — Illinois origin. Worthy of limited trial in Ontario. Plants run well and are moderately productive. Fruit medium to large, conic, medium red, bright, tends to bruise.

RECOMMENDED VARIETIES

(In order of ripening, from early to late)

General Markets

- (a) Commercial planting — Valentine, Premier, Dunlap (outside main producing areas), Sparkle.
- (b) Limited (trial) planting — Catskill, Empire, Fairland, Erie.

Special Markets

- (a) Commercial planting — Dorsett, Fairfax, Louise, Elgin (to pollinate Louise).
- (b) Limited (trial) planting — Suwannee, Temple, Robinson.

Home Use

Any of the above varieties may be planted in the home garden. A study of the descriptive notes on varieties will be a help in choosing sorts for particular needs.

POLLINATION

Most strawberry varieties in use today have complete (perfect) flowers. This means that they can be set in solid blocks and will fruit normally since each flower produces its own pollen.

Some older varieties such as Louise and Tupper have incomplete (imperfect) flowers. These flowers lack stamens which bear the pollen. Such varieties, to be fruitful, must be interplanted with a pollen-producing variety. The pollinating variety must bloom at the same period and should be planted as every third or fourth row.

LOCATION AND SITE

Strawberries for home use may be grown in any locality. However, for commercial production a number of factors must be considered, such as the availability of a variety adapted to local conditions, availability of markets or shipping facilities, satisfactory soils and sites and the supply of suitable labour. Another factor that is becoming increasingly more important is the availability of water for irrigation. Some growers now feel that over a period of years the ability to irrigate their strawberries will increase profits immensely.

The most important requirement of a site on which to grow strawberries is that the soil be suitable. The requirements for a satisfactory strawberry soil are discussed in the next section. The land should slope sufficiently and be free of depressions so that surface water drains away quickly. Strawberries are harmed if standing water is present even for a day or two. This is especially true at any time that the plants are active. If the land slopes to the extent that the soil washes, the strawberries should be planted on the contour. On steeper slopes where erosion is serious, it probably does not pay to plant berries.

In some localities the danger of spring frost hurting the bloom is of sufficient importance to warrant careful selection of the site from this standpoint. Only sites having a somewhat raised elevation and good air drainage should be used. In this way cold air will not accumulate, but being heavier, will descend to lower land.

The exposure of the site has a bearing on earliness of production. A southern slope will generally ripen fruit earlier than a northern slope. However, the danger of frost is greater on a southern slope. The presence of a windbreak aids in earlier maturity and helps prevent drying out of the plants by strong winds; also it will reduce the chances of the mulch being blown out of place.

SOILS

Strawberries do well on a wide range of soils. The soil should not be so light or coarse-textured as to be droughty and infertile. On the other hand the soil should not be so heavy or fine-textured as to be poorly drained and hard to manage. Good internal drainage is essential. Strawberry roots will not tolerate a saturated soil. Waterlogging increases root rot and brings about death of existing roots.

Varieties vary somewhat in their soil requirements. For instance, Premier is at its best on sandy soils whereas Catskill seems to do better on slightly heavier soils.

For most varieties a deep sandy or gravelly loam with a subsoil retentive of moisture, but open enough to permit excess water to get away, seems about ideal.

SOIL PREPARATION AND FERTILIZATION

Yields of 8,000 to 10,000 quarts of strawberries per acre are quite possible in Ontario, provided the soil is at or near its maximum state of productivity. This implies thorough and proper preparation of the soil prior to planting, maintaining the supply of plant food through to harvest, and having an adequate supply of soil moisture.

Organic matter may well be considered the key to productivity. On the lighter-textured soils where strawberries are commonly grown, organic matter is primarily responsible for maintaining an adequate supply of soil moisture. It also decomposes, releasing plant food gradually and continuously for plant growth. More important perhaps than this, is the fact that organic matter picks up and holds chemical fertilizer against leaching losses, and gradually releases it again over the growing season. In this way, heavy rains do not leach the fertilizer below the rooting zone of the crop.

You should consult Ontario Bulletin 457, Orchard Soil Management, for further detailed information on soil management in relation to horticultural practice. In the following section, methods of soil preparation with regard to strawberries are briefly outlined.

The strawberry is comparatively shallow-rooted and produces its crop in a relatively short period. Despite these facts, we strive to obtain crops of upwards of five tons of fruit per acre. This means that the soil must be in excellent condition. It must be well supplied with readily available plant food, have a high moisture-holding capacity and yet be well aerated. These three conditions are related in the sense that for any given soil type they are largely dependent on the amount of organic matter in the soil. In order to have plenty of organic matter present in a partially decomposed form, it is imperative that soil preparation commence the year previous to planting.

Organic Matter

The three common ways to add organic matter to your soil are applications of manure, applications of hay or straw, and working down green-manure crops. The method, or combination of methods, that you as an individual grower will use depends on your circumstances. If you are in general farming, you may be able to plough down a grass or legume sod and supplement with manure from your livestock. If you are a cash-crop farmer with plenty of land, incorporating green-manure crops may fit your programme best. On the other hand, if you are an intensive truck-crop or fruit grower you may not wish to take your land out of production for a year to grow a green-manure crop. In this case buying manure, or cut hay or straw, to apply along with an overwintering green-manure crop may be most satisfactory.

Manure — Thirty tons of manure to the acre may be used to advantage on strawberries. This is especially true on land that is being cropped intensively and where a green-manure crop has not recently been incorporated. Lesser amounts of manure can be used advantageously in conjunction with green-manure crops or hay and straw.

If the manure is well rotted and reasonably free of weed seeds, it may be applied in the spring prior to planting. Otherwise it should be applied the previous season and worked in. This will permit the manure to partially decompose before planting and allow weed seeds to germinate so that they can be destroyed.

Hay and Straw — Hay and straw are good substitutes for manure. Since hay and straw contain far less water than manure, a ton of either will be the approximate equivalent of three and a half tons of manure. These materials should be applied and disked in some time during the previous season, in order to have them sufficiently broken down by planting time. The non-legume hays and straws will need extra nitrogen to aid in their decomposition. Nitrogen should be applied at the rate of 75 pounds of ammonium nitrate per ton of material. Half of this can be spread over the material before disking and the remainder early the next spring.

Green-manure Crops — Various crops may be used for green manuring including buckwheat, sudan grass, rye, oats, corn, sweet clover, red clover, and soybeans. The last three named are legumes and are able to fix nitrogen from the air to increase the supply in the soil. All of these crops should be fertilized, and even manured where possible, to get maximum growth. It is desirable to let them mature slightly before working down, as mature material decomposes more slowly and is effective over a longer period.

Fertilizer

It is very difficult to state definitely what fertilizers should be used and in what quantities, without knowing something about the supply of plant nutrients, more particularly nitrogen, phosphorus and potassium, that are already in the soil in an available form. Soils vary greatly in this regard, so that the safest plan is to have them analyzed, at least for available potassium and phosphorus.

As available nitrogen varies considerably during the season, and as it is rather easily lost in drainage water, analysis for this element may not be a reliable guide in deciding whether to apply extra nitrogen. To be on the safe side, it is usually advisable to add some, unless the soil is unusually rich or unless large quantities of manure are used.

As a general guide to fertilizing strawberries the following suggestions may be helpful to you. If a green-manure crop is grown, it should be fertilized to achieve maximum growth. An application of 300 to 400 pounds of a complete fertilizer such as a 5-10-13 or comparable analysis may be used.

In the spring before planting, 400 to 800 pounds of 5-10-10, or even 10-10-10 if nitrogen is low, can be used, the amount varying with the intensity of soil preparation that has been followed. The lower rate should suffice if manure or green manure has been used. This fertilizer should be broadcast over the soil surface and worked in prior to planting.

A side dressing of nitrogen four to six weeks after planting frequently helps to stimulate early and abundant runner production. Ammonium nitrate at 75 to 100 pounds per acre is suggested. A second similar side dressing during mid-August is sometimes useful to aid in fruit-bud formation, since the fruit buds are formed in the autumn months.

Nitrogen applications in the spring of the fruiting year are not usually desirable. If too much growth is stimulated, fruit rots are a problem in a wet season and, in a dry one, the patch suffers excessively because of the extra foliage. In addition, excess nitrogen at this time will definitely make the berries softer. This greatly increases the difficulties of harvesting, shipping, and selling the fruit.

If, as occasionally happens, nitrogen does appear necessary, the application

should be light and delayed until after full bloom — too late to affect foliage growth but early enough to promote fruit development.

Soil Reaction

Strawberries will tolerate an acid soil so that liming is not normally necessary. In fact, there is evidence that applications of more than 1,000 pounds of lime per acre ahead of berries may be harmful, especially on coarse-textured soils.

Working the Land

The year previous to planting you should handle the land in such a way as to achieve three objectives: to destroy as many weeds as possible, to incorporate as much organic material as possible, and to have the organic material sufficiently decomposed by planting time as to facilitate planting. Delaying seeding of the cover crop until the first flush or two of spring weed-growth has been destroyed is helpful. Chemical weed sprays should be used where feasible on the green-manure crop or else a weed-smothering type of green-manure crop such as buckwheat can be used. If the green-manure crop becomes too weedy, it can be worked down and the land reseeded to another cover. The green-manure crops should be trash-disked prior to ploughing to facilitate faster breakdown. If an overwintering cover such as rye is grown, it should be worked in thoroughly very early in the spring so as not to interfere with planting.

Prior to planting, the land should be worked sufficiently to prepare a deep and reasonably loose "seed-bed." This permits of a better job of planting particularly if a planting machine is used.

ROTATION OF STRAWBERRIES

The prevalence of root rot in the older strawberry-growing districts has been brought about to a great extent by overcropping with strawberries; strawberries have followed strawberries too soon and too often on the same piece of land. This has resulted in a building up in the soil of the organisms that cause strawberry root rot; hence it is now recommended that strawberries should not be grown more than once in five years on the same land. Just what crops can be used in a long rotation will have to be determined by the individual grower. On small areas of expensive land it may be difficult to work out satisfactory rotations, but cash crops will, of necessity, be used to a considerable extent. On large areas of comparatively cheap land, the strawberry can be fitted in more readily with other farm crops and various green-manure crops.

DIGGING PLANTS

Strawberries are usually dug by a team of two people. One forks out the plants and shakes most of the dirt free from the roots, the other finishes the shaking by hand, counts and bundles the plants.

Recently some large growers have been using homemade diggers to facilitate lifting plants. All that is necessary is a blade about 6 inches wide and long enough to cover the width of the row. This blade is sharpened along the front edge and mounted on a frame with wheels or directly onto the hydraulic lift of a tractor. The blade cuts along at a slight angle at a depth of 6 or 8 inches.



For the new patch, select healthy-rooted plants only. Plant at left, roots nearly all healthy and fibrous; centre plant, some root rot (black root) and lacking fibrous roots; right, severe root rot.

The plants are lifted and dropped back loosely so they can be forked out with extreme ease or even pulled out by hand.

It is also possible to use a potato digger, especially some power take-off models. The normal V-shaped blade is replaced by a blade that is made up with a straight cutting edge about 30 inches long. To help feed the plants onto the chain, which is narrower than 30 inches, the outside rear corners of the blade are turned up. The plants move back over the chain and drop to the ground with all the dirt shaken from the roots. They must be picked up quickly to prevent drying out.

PLANTING

Systems of Planting

In Ontario, the "matted row" system is used in nearly all commercial plantations. By this method the new runner plants are allowed to root at will until a full row 20 to 30 inches in width results. The "spaced matted" row is perhaps more desirable, where the density of the plants is controlled by some runner placement and thinning out. The "hill" system, where single plants are set and all runners removed is not adapted to Ontario conditions and varieties. This method is more common in British Columbia and results, where practical, in large berries of high quality.

Distance of Planting

The width between rows is largely determined by the type of equipment such as tractors, cultivators, sprayers and so on that you use in the plantation.



Select strong, young, healthy crowns. (1) Old elongated crown and sparse root; (2) both crown and root too small; (3) too small, undeveloped plant; (4) well-developed plant.
(Courtesy, Dominion Department of Agriculture)

Rows are usually set 4 feet apart although some growers use $3\frac{1}{2}$ feet or $4\frac{1}{2}$ feet. In general, closer rows, providing the plants are not allowed to become too dense, will give higher per-acre yields than wide-set rows.

The distance between plants in the row should be varied according to the variety and soil conditions. Varieties that produce many runner plants should be set as far apart as 24 inches or more to prevent the rows from becoming too dense. The plants should not be set so far apart that the late runner plants are necessary to fill in the row since these late-set runner plants are not nearly as productive as early-set runners. Moderate plant-makers such as Premier are commonly set at 18 inches although this distance can be varied from 16 to 20 inches to control plant density.

Number of Plants Per Acre

To find the number of plants required to plant an acre: multiply the distance between plants in a row, say $1\frac{1}{2}$ feet, by the distance between rows, say 4 feet; thus, $1\frac{1}{2}$ feet by 4 feet equals 6 square feet. Divide this into 43,560, which is the number of square feet in an acre. The result, 7,260, is the number of plants required for one acre at this distance of planting.

Selection of Plants

It should be obvious that there is no point in doing a good job of soil preparation, fertilization and so on unless well-grown healthy plants are used. Many growers now rely on getting their plants from nurserymen who specialize in producing good quality plants.

Some American strawberry nurseries now maintain expensive screen houses to keep their own planting stocks virus-free. The plants from these screen houses are propagated in fields that have been fumigated and treated with



The type of plant to set: vigorous, well-developed, and with a clean, strong, fibrous root-system.
(Courtesy, Dominion Department of Agriculture)

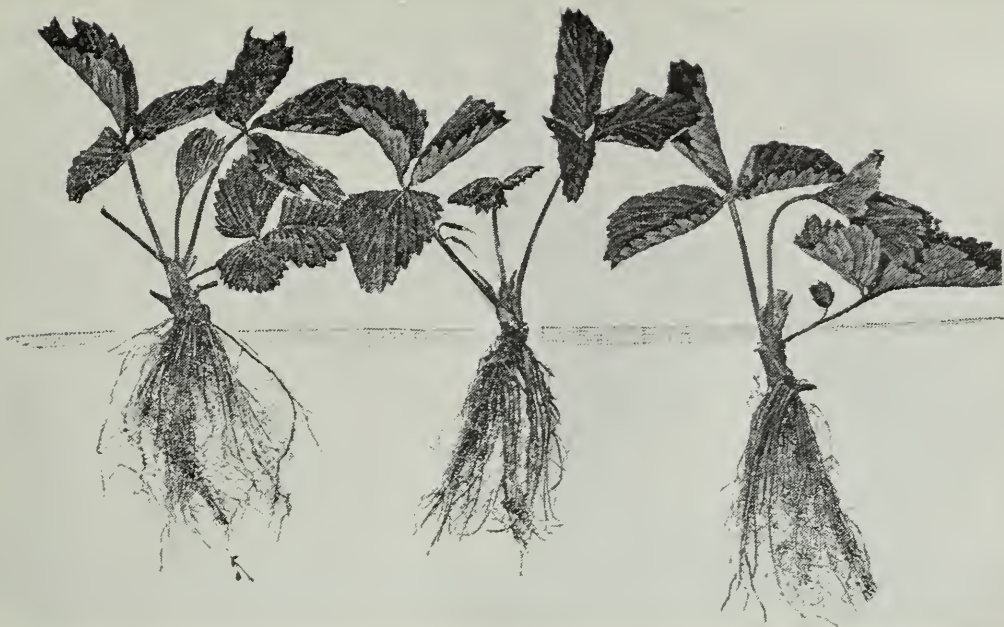
insecticides to control soil pests. In addition, the fields are sprayed frequently to control aphids which could bring virus into the planting. The plants are machine-dug early while still dormant, graded and placed in cold storage. In this way dormant plants, free of disease and uniform as to grade, are made available to growers.

Progressive Ontario plant-growers have watched these developments and are beginning to adopt similar methods. In the future you may find it profitable to purchase your plants, if not every year, at least periodically from such nurseries.

If you have a stock of plants that has been performing well, you may wish to dig your own plants. In such case you should dig the whole row, discarding the old mother plants, small, late-rooted plants, and plants that show any serious browning on the roots or in the crown. Only plants with well-developed crowns, an abundance of creamy white fibrous roots, and without any serious browning in the internal parts of the crown should be used.

Time of Planting and Cold Storage

Strawberry plants should be planted as early as it is possible to prepare the land. In this way the plants become established before the onset of hot, dry weather. Well-established plants runner earlier which is important because early-set are more productive than late-set daughter plants.



The plant should be set so that the crown is level with the ground surface. The centre plant above is correct, the left plant is too shallow, and the one on the right, too deep.
(Courtesy, Dominion Department of Agriculture)

Another advantage of early planting is that the plants are still dormant when planted and dormant plants will establish themselves better than plants that have started into growth. A strawberry plant comes through the winter with a certain amount of stored food with which to start growth in the spring. If planted while still dormant, it still has all of this reserve food with which to withstand the shock of transplanting, and to start growth in its new location. If the plant has started into growth before being dug and transplanted, it will have put out new roots and used part of its reserves. Many of these new roots are destroyed in transplanting so the plant has to replace them and start off in its new location on a partially depleted food-reserve.

If you are unable to plant early, you should arrange for a supply of dormant plants by having them dug early and placed in cold storage at 30 to 32 degrees Fahrenheit. It is very important to keep the plants moist while in storage. This can be done by keeping the humidity high in the storage room through hosing down the floors and by packing the plants in moist packing materials such as moss. Plants will hold for several months without harm if kept cool enough and moist enough. Only fully dormant plants should be stored. Plants that have started into growth do not store well and should not be held more than a few days.

Fall planting, late October or early November, can be done successfully but such a practice is only desirable where it is not possible to plant early in the spring. Fall-set plants must be mulched to prevent heaving and winter injury so they require two mulchings as they do not bear fruit until after the second winter. Special arrangements must be made to obtain plants for fall planting as nurserymen do not normally dig until spring.

Setting the Plants

The old leaves and runners should be cleaned off and the plants placed in bundles for machine planting in order that they may be handled quickly.



For large acreage, machine planting is almost a necessity.
It speeds operations, waters the newly-set plant.
(Courtesy, Macdonald College)

For hand planting, there does not appear to be any advantage in having the plants fully cleaned. This saves labour if you dig your own plants and saves money if you buy them, since rough-cleaned plants are usually somewhat cheaper.

The plants should not be permitted to dry out at any time between digging and setting. They should not be exposed to the sun or wind for any length of time. Planting on a cool, cloudy, still day is preferable to planting on a hot, sunny, windy day. For short periods the plants may be protected by moist sacking or placed in the shade. For longer periods they should be heeled in a shallow trench or placed in cold storage.

Hand planting is most commonly done by two people working together and using a spade. One person thrusts the spade into the ground at a slight angle and pushes the handle forward — but not to and fro — leaving a wedge-shaped hole behind the spade. The other person then places the plant with roots somewhat spread into the hole and the spade is withdrawn so that the soil falls back on the roots. The foot is then used to firm the soil properly around the roots, care being taken not to injure the crown. Plants should be set so that the mid-point of the crown is level with the soil surface (see illustration). If set too deep, the young growing shoot may be damaged or may rot; if set too shallow, the roots are exposed and will dry out.

Machine Planting

Properly used, a mechanical planter does a good job of planting and is much faster. Upwards of 25,000 plants can be set in a day by experienced workers. The plants can be watered at the same time and fertilized if desired.

Dry fertilizer may be applied as a side dressing or added to the water tank in the form of starter solution. The dry fertilizer should not be allowed to contact the plant roots but should be placed as a band on each side of the row.

For best results with a planter, the plants should be cleaned and placed in orderly bundles. The soil should be worked down to a fine state of tilth and to a good depth. The two common errors with machine planting are that the plant roots are not set deep enough, or firm enough. Proper soil preparation aids in getting the plants set with the roots straight down. In some cases it is necessary to have a man follow the planter to firm the soil by foot, to straighten misplaced plants and fill in vacancies. Some growers find that rolling the field following planting helps in establishing the plants.

CARE OF YOUNG PLANTATION

Since the kind and amount of growth made during the first season largely determines the size and quality of the next year's crop, special attention must be paid to cultivation, weed control, deblossoming, and the development of a desirable type of matted row.

Cultivation and Weeding

Cultivation should begin shortly after planting and be repeated as often, but only as often, as is necessary to control weeds and to maintain a mellow soil. This is to encourage growth of the mother plant and rooting of the runner plants. The strawberry is a very shallow-rooted crop therefore cultivation should be as shallow as possible. A spike-tooth cultivator is perhaps more desirable than a wide-tooth type. Cultivation aids in soil aeration thus promoting root growth and desirable bacterial action in the soil which in turn releases plant food. However, if carried to excess, organic matter is needlessly broken down and soil structure destroyed. In addition, constantly turning up moist soil results in increased water loss.

You, as an individual, will have to decide how often to cultivate. The frequency will depend on your soil type, the amount of weed growth and the frequency of heavy packing rains. You will find it desirable to cultivate always in the same direction on a particular row in order to minimize disturbing the runners already trailed into position.

Hand hoeing around the young plants is necessary for weed control and to keep the soil mellow. This hoeing should be quite shallow and done in such a way that soil is moved towards the plants rather than away. It is often possible to combine hoeing with such operations as deblossoming, runner replacement, and runner removal.

Chemical Weed Control

You can save yourself labour and money by the use of chemical weeding in your strawberry plantation. The chemicals now being used are quite safe and after you have learned how to use them properly on your own place with your own sprayer, you will not want to be without them.

This field is still changing fairly rapidly and for the latest information you should secure a copy of Ontario Extension Circular No. 75B "Chemical Weed Control, Horticultural Crops" or contact your district Horticultural Fieldman.

Crag Herbicide is the best material for general weed control. It is used

at 2 to 4 pounds per acre, the higher rate being used on heavier soils. At these rates this material will not harm the berries but is effective only on weed seedlings. Crag will not control weeds that are over $\frac{1}{4}$ inch in height so that larger weeds must first be destroyed by cultivation and hoeing. Moisture is necessary for Crag to be effective so it should be applied only to a moist soil or to a dry soil prior to rain or irrigation. Effective control for periods of 3 to 6 weeks may be obtained. Cultivation, of course, destroys the effect and brings up fresh weed seeds. Several applications may be made during the season. Do not apply until 7 days after planting.

Crag Herbicide does not dissolve too readily so you should mix up the required amount thoroughly in a pail of water before adding to your sprayer. The material is quite safe in the sprayer providing the sprayer is rinsed once or twice after use. There is very little danger of damage from spray drift while applying.

The important thing is to apply the proper amount of Crag to the acre. This may be done in any convenient amount of water. For low-pressure, low-volume sprayers, 40 to 60 gallons may do the job whereas for high-pressure orchard rigs, you may require 120 to 140 gallons to cover an acre properly.

For established broad-leaf weeds, 2,4-D at the rate of 8 ounces of actual acid per acre may be used. You may observe some apparent injury to the plants following this treatment but it does not reduce the yield. Spray drift of 2,4-D can cause damage to sensitive crops such as grapes and tomatoes. The sprayer should be **very carefully** rinsed after using or, better still, use a separate sprayer.

Chickweed is a serious fall weed in many strawberry patches and neither Crag nor 2,4-D is particularly effective. Recent results indicate that Chloro IPC at the rate of 3 pounds per acre between October 15 and December 15 will control chickweed with absolutely no harm to the berries. Chloro IPC is quite specific for chickweed but the kill is quite slow and you may not see much effect of the spray for several weeks.

Weeding with Geese

Geese do not like strawberry foliage so you can pasture geese in your planting and they will do a good job of controlling grasses and most broad-leaf weeds. There are certain weeds that geese do not eat such as round-leaved mallow and smartweed but most others they will eat, especially while the weeds are young and succulent. Geese will not destroy strawberry plants unless desperate for food.

Experience indicates that the smaller breeds of geese such as the Chinese and African are better foragers than the Toulouse, which is the common heavy grey bird raised in Ontario. From 4 to 6 geese per acre are required and a new hatch of goslings 5 to 6 weeks old should be used each year as old birds do not pasture as extensively. It is necessary to enclose the patch with a 3-foot chicken-wire fence and to provide shelter and water. In addition some extra food may have to be supplied if the weed growth is not sufficient to provide food for the birds. The use of geese for strawberry weeding is quite common now in various parts of the United States.

Blossom Removal

Removal of the flower stalks on newly set plants results in the development of 4 or 5 times as many leaves on the plant. These extra leaves manu-

facture more food and the plant responds by sending out more than twice as many runners. For these reasons it is very important to pinch off the flower stalks. You should wait until the bloom has developed enough that the whole stalk can be pinched out and not just individual blooms.

Thinning and Spacing

There is abundant evidence that the density of plant stand in a strawberry row markedly affects yield. If too many plants are present, yield is reduced because of crowding and competition for water and plant food. Whenever your fruit-size falls away drastically after the first picking or two, the first thing to suspect is that the plants may be too dense.

Ideally, one to four plants per square foot, well rooted by early August, seems optimum. Later runner plants may well act only as "weeds" and should be eliminated in some way. Down on Cape Cod in Massachusetts, strawberries are grown by what is known as the Cape Cod system where only two runners are allowed to develop from each plant. These runners are brought out at right angles to the row and permitted to set two plants each about 10 inches apart. In this way there is only about one plant per square foot. This system results in yields ranging from 15,000 up to 19,000 quarts per acre of large-sized fruit.

You would do well to consider some sort of thinning-out of late runners and proper spacing of the early ones. Wider planting distances for vigorous running varieties will help. Some runner-placing during hoeing should also be practised. Late runners should not be trailed back into the row by cultivation but allowed to grow out into the pathway. They can then be cut off by hand or removed by attaching a rolling coulter to the front of your cultivator. Anything that you can do to remove these late runners cheaply will be desirable.

MULCHING

Reasons for Mulching

There are a number of reasons for fall mulching: to prevent actual frost injury to crowns and roots, to reduce root rot, to counteract the effects of fluctuating temperatures which cause the plants to heave, and to check desiccation by cold dry winds. When raked between the rows in the spring the mulch depresses weed growth, conserves moisture, keeps the berries from being splattered by soil during rains, and makes picking more pleasant.

Experimentally, it has been shown that even fully hardened strawberry plants are injured when the plant-tissue temperatures fall to about 18 degrees above zero. Such tissue-temperatures are avoided if the plants are protected in some way, either by snow or mulch. Since we cannot safely rely on snow cover to do the job for us, we need to mulch as a guarantee against winter injury. In addition, root rot is often far more serious on plants that have been injured by low temperatures.

It is true that some unmulched patches in certain years do not appear to suffer much injury and yield very well. However, there is no assurance that these patches wouldn't have yielded even more had they been mulched. Nor can we be sure that injury occurred that particular winter as there may have been snow present during cold snaps. Experience and experimental trials indicate that, year in and year out, mulching will result in increased yields.



Mulching. In winter the mulch protects the plants from injury by low and fluctuating temperatures. In summer, placed between the rows, it conserves moisture, keeps the fruit clean.

Time of Application

At one time it was recommended that the mulch be applied only after the ground was sufficiently frozen to support a loaded wagon. We now know that injury may occur at an earlier time. The plants should be covered before being exposed for any prolonged period to temperatures below 18 degrees Fahrenheit, but not before they have been well hardened by several sharp frosty nights. It is advisable to have the mulch in readiness to apply at the proper time. If you have a large acreage to cover, you could start after the first one or two sharp frosts. In general, the mulch should go on sometime between mid-November and early December.

Materials to Use

Wheat straw, rye straw, marsh hay, and strawy manure are all used as mulching material. Oat straw may also be used, but this may pack down too closely. Old hay is suitable, also shavings. Good results are reported from Nova Scotia on the use of sawdust; however, too fine a sawdust could cause injury by smothering. Any mulching material likely to contain weed or grain seed should be placed in loose piles out in the rain and sun for a month or two before it is needed, so that these seeds may germinate. Many seeds may be removed simply by thoroughly shaking out the material before using it.

Straw that has been pick-up baled behind a grain combine will not contain as many weed seeds as straw baled out of a straw stack. The reason is, of course, that the weed seeds fall to the ground surface when the straw leaves the combine and are not picked up with the straw by the baler.

The quantity will vary somewhat with the material but the mulch should be 2 to 4 inches thick when settled. For straw, this requires about $2\frac{1}{2}$ to 3 tons per acre.

Mulch Removal

The mulch is removed in early spring, usually about the middle of April or when new leaves are just beginning to show under the mulch. If left too late,

injury to the plants may result, but the main objection to leaving it on too long is that blossoming and fruit ripening may be delayed. In some localities the resultant delay in blossoming time may be an advantage on account of late frosts. Also, where plants are grown for sale, the mulch is usually removed as digging proceeds so that the digging season may be lengthened.

The mulch is normally raked into the pathways between the rows and tramped down where it will serve to save moisture, keep down weeds, keep the berries clean, and make picking more pleasant.

FROST INJURY

In some seasons, spring frosts occur during strawberry bloom time and cause damage to open blossoms and even those not fully open. In some cases pistils (female parts) may be completely frozen in which case no fruit develops. In other cases only partial injury occurs and unevenly formed fruits result.

Under Ontario conditions, bloom frosts do not occur very often and then only during early bloom so that only the first blossoms are hurt. The losses are not usually very serious so that the selection of a site with good air drainage is about the only precaution necessary. If a given site is suspected of being subject to frost injury, delayed removal of the mulch will help hold back bloom until the danger of frost is past.

Sprinkler irrigation can be used for frost protection. Water is applied slowly, at the rate of 1/10 inch per hour starting just before the temperature reaches the freezing point. The irrigation must be continued until the temperature rises again and all the ice melts. The reason that this irrigation provides protection is that the conversion of the applied water to ice on the plants releases heat and counteracts the low air-temperature. Growers in South-western Michigan, where frosts frequently occur at full bloom and seriously reduce crops, are using this method. They find they can get protection from 4 to 5 degrees of frost in this way.

IRRIGATION

Moisture supply from bloom to end of harvest is undoubtedly the most important single factor affecting yield. Strawberries are quite shallow rooted, deriving nearly all of their moisture from the top foot of soil. While there is no precise information available, strawberries probably require from $\frac{3}{4}$ to $1\frac{1}{4}$ inches of water per week during fruit development and harvest. The lighter strawberry soils will have as little as 1 to $1\frac{1}{4}$ inches of available water in the top foot and the heavier strawberry soils will not have over 2 inches.

From these figures, you can readily see that strawberries can use up all of the available moisture in from one to two weeks unless the water is replenished by rain. The importance of irrigation is readily appreciated when you consider how often we run into spells of one to two weeks with little or no rainfall during the strawberry season.

Economic surveys of returns from irrigation on various crops indicate that strawberries are likely to return a greater profit from irrigation than almost any other crop. If you grow any appreciable acreage of strawberries year after year, and if you have a supply of water available, you would be well advised to consider irrigation. This is especially true if you are growing on your farm other crops such as vegetables which could also benefit from irrigation.

For information and assistance on irrigation, you are advised to apply to the Department of Agricultural Engineering, Ontario Agricultural College, Guelph.

Irrigation must be used with some care on strawberries. If used too freely, excessively soft fruit, that will not ship and handle well, will result. In addition, losses from fruit rot are more serious on this soft fruit especially if the foliage becomes too dense and is kept wet.

Growers who have irrigation find it to advantage to irrigate occasionally during dry spells in the first year to encourage earlier and greater runner development. It is obvious that unless good rows are formed during the first year, no amount of effort in the second year can result in high yields.

PICKING AND PACKING

The strawberry harvest in Ontario begins about the end of the first week in June and lasts three to four weeks. If the weather is hot and dry, the season is shorter than if the weather is cool.

In order to properly harvest the crop, it is necessary to have enough good pickers to keep up with the picking, that is the patch should be picked at least every second day. During very hot weather, it may be necessary to pick daily to have fruit of good quality for the fresh fruit market. From six to nine pickers per acre will be required, the number depending on the experience of the pickers, the size of the crop, and the rate at which the berries are ripening.

If your patch is small, you may be able to get enough help from your immediate family and neighbours, or from nearby villages. For larger patches it may be necessary to bring in pickers from towns and cities some distance away. If your planting is in a major strawberry area you will usually find that casual workers are attracted to the district for the strawberry harvest.

Proper picking and packing is very important inasmuch as an attractive pack always sells readily and may bring a premium price. Proper instruction of the pickers and careful supervision are very important to ensure a quality pack. Good pickers are sometimes paid by the hour to encourage them to take time to put up a good pack although, normally, pickers are paid by the box or carrier. In this case constant supervision is necessary. The simplest way to keep a record of each picker's earnings is to supply the individual with a card which is punched for each full box or carrier.

The berries are ready to pick when three-fourths to all red. Berries should not be allowed to get overripe. If overripe and dry they sour, if overripe and damp they rot. Wholly green berries do not ripen properly after picking and spoil the quality of the pack. The berries should be cupped in the hand and the stem pinched off between thumb and forefinger. In this way the fruit is not crushed and is picked with the calyx, or hull, still on, and with only a very short stem. To avoid crushing, only two or three berries should be held in the hand at one time.

The pickers should be instructed to pick all berries that are ripe and not miss any, as these missed berries become overripe and even rotten by the next picking. It is sometimes desirable to have the pickers place any deformed, overripe, small, green, or rotten berries that they may pick in a separate box in the carrier. The picker is then paid for this box which is discarded. In this way, cull fruit that is accidentally picked is kept separate from the good fruit and is also removed from the patch.

It is very important to move the berries into the shade as quickly as possible

after picking. Temporary shacks should be used where other shade such as trees is not available. Some growers have such a shelter mounted on skids or wheels so that it can be moved along the edge of the patch or from end to end to be always near the pickers. The best quality fruit for fresh market is obtained by picking only during the cooler parts of the day. Berries picked during extreme heat never look as attractive as berries picked in cooler periods.

In Ontario, strawberries are picked and packed in quart boxes. The pickers are commonly supplied with carriers which are flat trays holding 6 or 8 quart boxes. These carriers when filled are taken to the packing shed where the boxes are checked for quality, topped off, and placed in crates. The 27-quart crate is commonly used in Ontario although the 24-quart crate is very popular in Norfolk county.

RENEWAL OF THE PLANTATION

The practice of taking a second crop from a plantation is favored by some growers. However, it is conceded that renewal is only worthwhile providing the plantation is healthy, vigorous, and reasonably free of weeds. The argument for taking a second crop is that it can be produced for relatively little extra cost except for labour. Usually, the second crop is less than the first crop but the berries ripen earlier.

The strawberry enters a period of arrested activity toward the end of fruiting during which very little new growth occurs and many of the smaller feeder roots die off. In addition, when new growth starts again, too many new runner plants are produced unless some of the original plants are destroyed. Renovation practices are aimed at starting the plant into renewed growth sooner and in removing many of the plants so that the resulting row will not be too dense.

The common method of renovating a patch is to narrow the rows down by plough, cultivator, or rotary tiller. The last named implement works very well, particularly if some of the teeth are removed in the case of larger models. Rotary tillers permit the straw to be easily incorporated. There is no evidence that narrowing the rows from one side only is any better than narrowing from both sides. The row should be cut back to a 6- or 8-inch strip and the plants thinned in this strip either by hand or by cross rototilling with alternate teeth removed or two out of every three teeth removed.

Mowing a plantation after fruiting appears to be desirable in that a new leaf surface soon results to replace the old leaves. In addition, only as many new leaves are produced as can be supported by the reduced root system which results from the death of feeder roots.

Perhaps the ideal way to renovate a patch is to mow it without narrowing the rows. In this case the plants should be thinned out to a desirable density and new runner development controlled to prevent the row becoming too crowded. In this way the original plants produce most of the fruit. Experimentally, this method has been shown to produce very high yields in the second crop. This is because the original plants are capable of producing more fruit than runners coming from such plants. However, the cost of removing runners is so high as to make this method unattractive.

Regardless of the method of renovation, there are several points to keep in mind for success. The renewal should be done **immediately** after the last picking. Fertilizer, especially nitrogen at about 100 to 150 pounds of ammonium

nitrate per acre, should be supplied. Occasionally, potassium and even phosphorus may be necessary. Wherever possible, irrigation in dry weather immediately after renovating is of immense help.

Following renewal, the planting is handled in a manner similar to a first-year patch. Proper mulching may be of more importance in a second-year patch because of the tendency for the crowns to be higher out of the ground.

YIELDS AND RETURNS

The average yield of strawberries in Ontario in 1955 was just over 2,000 quarts per acre. Good growers would consider this yield as quite low. Yields of 5,000 to 6,000 quarts are more common among such growers. Yields of 8,000 to 10,000 quarts have been obtained in Ontario often enough to indicate that this is where a strawberry grower should set his goal.

The Farm Economics Branch, Ontario Department of Agriculture, conducted a cost of production study on strawberries in Ontario from 1951 to 1953. The results of this study have not been published at time of this writing (March, 1956) but permission has been granted to quote some preliminary figures which are of interest.

Records were obtained from 76 growers spread over the main producing areas in the province. The results show that the average yield for all growers over the three-year period was 4,946 quarts per acre, the average cost of production (exclusive of crates and boxes) was \$719 per acre which gave a net return of \$317. Labour constituted almost half of the cost of production.

The effect of yield on net returns was particularly striking. Yields of less than 3,000 quarts per acre resulted in a net loss to the grower. Growers whose yields were between 4,000 and 5,000 quarts had an average net return of \$269 per acre, whereas growers whose yields were 8,000 quarts and over had an average net return of \$1,080 per acre.

It is therefore obvious that proper attention to all factors that will increase per-acre yields will, in general, result in greater profits from growing strawberries. Obviously, there is a limit to the amount of money that can be spent to obtain high yields and still realize additional profit from the increased yields. However, there are a number of things that a grower can do to increase yields without spending very much additional money. Some of these are as follows: selection of proper location, soil and site, use of high quality planting stock, careful planting at the proper time, shallow instead of deep cultivation, proper blossom removal and adequate mulching at the right time.

EVERBEARING STRAWBERRIES

Everbearing or fall-bearing strawberries differ from the June-bearing sorts mainly in their fruiting habit. In the June-bearers, fruit buds are formed in the shorter cooler days of the fall, but they do not grow into flower stalks until the following spring; whereas the fruit buds of the everbearing varieties are formed through the long hot days of summer and continue to develop into flowers and fruit as they are formed. The June-bearers produce their fruit during three or four weeks in June and early July, while the everbearers produce their crop throughout most of the summer and fall.

The common practice with the everbearing sorts is to plant them in the spring and keep the blossoms picked off until the middle of July, but from

then on they are allowed to develop and produce a fall crop. If kept for a second year they may produce an early summer crop, also a small second fall crop. The quantity and size of fruit will depend very much on the condition of the plants that second spring and also on weather conditions. If the plants are weak and poorly grown, or if the summer is hot and dry, with no irrigation, there will be very little fruit.

Everbearers are perhaps more trouble to grow than the June-bearing sorts and yields are not likely to be as high. However, even with higher production costs and lower yields, they may be profitable if high enough prices are obtained for out-of-season fruit. In districts where late spring frosts are likely to occur, the everbearers may prove particularly useful. Some of the earlier blossoms may be destroyed, but later ones will escape the frost and produce some fruit.

An extra-good strawberry soil, well supplied with organic matter, is a prerequisite for success with everbearers. Some form of irrigation, too, is a practical necessity during hot, dry weather. Soil deficient in fertility can be greatly improved by the addition of manure or straw and a good mixed fertilizer as recommended for June-bearing sorts (see Page 12).

As the everbearing varieties usually produce few runners, they are better adapted to "hill" culture than to the matted-row system. If grown in the matted row, they will need to be set somewhat closer than the June-bearing varieties. Suitable distance for "hill" culture are 12 to 15 inches between plants, in rows 36 inches apart. For the matted row they could be set 15 to 18 inches between plants, with rows 36 to 42 inches apart.

A grower in Ohio has developed a system for growing everbearing strawberries which seems to have some promise.* The plants are set in beds four rows wide, with plants 12 inches apart in each direction. The bed, with a narrow alley on both sides, is 60 inches wide. This allows for picking two rows at a time from each side. This close planting requires 35,000 plants for an acre. As no runners are kept, even if some do form, the whole planting consists of mother plants only. This, of course, is the case with any "hill" system; and, too, it should be noted the loss of a single plant causes a bigger gap than in a matted row.

The unique feature of this particular system is the use of a sawdust mulch. All the space between the plants is kept completely covered with sawdust an inch deep, which checks evaporation of moisture from the soil and keeps the fruit clean. As no rooting of runners is needed, it can be placed close up around the plants. Although only a depth of one inch is used, about 150 cubic yards will be needed to cover an acre.

The young plants must be very thoroughly hoed and weeded before the sawdust is applied and this is done right after the hoeing. A horse cultivator cannot be used, as the plants are set too close; neither should a hoe be used after the mulch is applied, so that all future weeding must be done by hand pulling. To reduce this hand weeding to a minimum a soil practically free of weed seeds is a necessity.

Even though high yields of large fruit — 4,000 to 7,000 quarts per acre — may be obtained by this system, yet it is questionable if it could be used in a large way because of the great amount of extra work involved. It is estimated

* Reported in "Ohio Farm and Home" for January and February 1949 and January and February 1950 by Wesley P. Judkins.

that four times the amount of work would be required for this method as for the matted-row system.

As no runner plants are saved in the fruiting bed by the "hill" system, it is necessary to grow a plant-increase bed or buy plants from elsewhere for setting out new plantations.

When the old plantation is past its usefulness, it will naturally be plowed down. However, to assist in the rotting of the rather large bulk of sawdust, it will be advisable first to apply a light dressing of well-rotted manure or some readily available nitrogen fertilizer, such as ammonium nitrate, using about 75 lb. per acre.

The varieties of everbearers most commonly grown in Ontario in the past were Gem and Mastodon. At present however, two new varieties, Superfection and Red Rich, are taking precedence.

Both of these varieties are superior to the older sorts. Superfection is an improved Gem with many of the qualities of Gem. It is vigorous, productive, and performs well on a wide range of soils. Red Rich is less vigorous and productive than Superfection but the quality of the fruit is somewhat superior.

INSECTS AND MITES OF THE STRAWBERRY

H. W. Goble, Dept. of Entomology, O.A.C., Guelph

The important pests of the strawberry in most areas of Ontario are the strawberry leaf roller, spittle bugs, two-spotted spider mite, and white grubs. The strawberry weevil at times is a serious insect. The strawberry leaf beetle, cyclamen mite, and cutworms are occasionally important.

STRAWBERRY LEAF ROLLER (*Ancylis comptana fragariae* [W. & R.])

The adults are small, brownish moths. The larvae, which cause all the injury, are small, greenish or bronze caterpillars which roll the leaf or fold part of the leaf and feed in the folded part (see illustration). A strawberry planting that has been heavily attacked will be greyish instead of being rich-green in colour. The injury is usually more severe late in the season on new plantings. There are two or three broods of larvae a year.

Control — Plough down the plantation immediately after harvest unless it is to be held over for another year. If another crop is to be harvested, mow the planting immediately after harvest and spray or dust it in August as directed below if any leaf rollers are present. With new plantings, for first brood larvae, spray or dust during the first or second week in June and repeat in ten days. For second brood, spray August 15 and repeat in ten days. Use one of the following in 100 gallons of water:

- (1) 50% DDD (TDE) wettable powder 2 pounds
- (2) 15% parathion wettable powder 1½ pounds
- (3) 25% malathion wettable powder 2 pounds

Apply 200 gallons of spray to the acre.

If you prefer to dust, use 7% DDD (TDE) dust at 25 pounds per acre.

Of the above materials, parathion will give the best control if there are large larvae or if the leaves are rolled. Very thorough spraying is required with malathion. Observe all safety precautions especially if you use parathion.

SPITTLE BUGS

These insects are readily recognized by the presence of spittle-like masses on the leaves, flowers, or stems of the strawberries. As soon as the eggs hatch, the nymphs or young form a very small drop of frothy material which increases in size as the nymphs of the insects grow. There may be one or a number of insects in each spittle mass. Where plants are infested, spittle masses may still be found in the patch at picking time on both the leaves and fruit. These insects feed by sucking the juices of the plant. The spittle-like material is objectionable on the berries. The fruit may be reduced in size as a result of feeding by the insects.

Control — This insect requires control in some plantations. Sprays of DDT have given good control when applied before the spittle bug nymphs are full grown. Spray when the first blossoms appear with 50% DDT wettable powder 2 pounds in 100 gallons of water (100 gallons of bordeaux or captan if leaf spot, blight, scorch, or fruit rots are also present). Use sufficient pressure to drive the spray into the spittle masses.



Strawberry leaf roller injury.

TWO-SPOTTED SPIDER MITE (*Tetranychus bimaculatus* HARVEY)

Two-spotted spider mites, often called "red spiders," are one of the most important pests of the strawberry. They are so small they are just visible without the aid of a hand lens. They are pale in colour and usually have two darker areas on their backs with these spots sometimes very indistinct.

These mites suck the sap from the undersides of the leaves and, if heavily attacked, they will turn a rusty-brown colour. When a heavy attack occurs during picking time, the yield will be greatly reduced. Infestations later in the season or on new plantings will reduce the growth and vigour of the plants.

Control — (1) Mulch with new straw, or straw that has not been used before for mulching purposes, as straw that has been previously on a strawberry planting may carry hibernating mites.

(2) First-year non-bearing patches and any planting after picking. If mites appear, spray with 15% Aramite wettable powder $1\frac{1}{2}$ pounds of 40% TEPP liquid $\frac{1}{4}$ pint in 100 gallons of water. Repeat in seven to ten days.

During the picking season, spray with TEPP as given above immediately after picking and do not pick again for at least three days. Place warning signs in the plantation for this three-day period. Take all necessary precautions concerning the safe handling of TEPP.

WHITE GRUBS (*Phyllophaga* spp.)

White grubs are the larvae of June beetles (see illustration). Strawberries are very susceptible to injury by these pests. The grubs eat the roots of the



White grubs in soil.

plants usually killing them. Since the beetles prefer to lay eggs in grassy areas and sandy soil, they are more destructive where the land has been in sod within the last two years and on light soil.

These insects have a three-year life cycle and since most of the damage is caused by two-year-old grubs, the injury is more severe every third year. A large population of two-year grubs, the injurious stage, is expected in most of Ontario in 1957 and again in 1960. The exception is an area around Oshawa and extending west along Lake Ontario in Ontario, York, Peel, and Halton counties and in the Niagara Peninsula where the most severe damage is expected in 1956 and 1959.

Control — (1) Do not plant strawberries on grub-infested land.

(2) Do not plant strawberries on land that has been in sod within the last two years.

(3) Chemical treatment. The following insecticides have given good control under most conditions but the exact effective rate may vary with the soil type. The following are the amounts of actual insecticide suggested per acre with an example of a dust type. Apply emulsions, wettable powders, or granular types to give equivalent amounts of actual chemical per acre: (2) heptachlor 5 pounds (e.g. 2½% heptachlor dust 200 pounds per acre); (b) aldrin 5 to 6 pounds (e.g. 5% aldrin dust at 100 to 120 pounds per acre); (c) chlordane 5 to 10 pounds (e.g. 5% chlordane dust at 100 to 200 pounds per acre). Use the heavier rates on heavy and muck soil. Work the material into the top three or four inches of soil immediately after application.



Strawberry weevil damage. The stems of the buds have been partly or completely cut.
(Courtesy, Dominion Department of Agriculture)

STRAWBERRY WEEVIL (*Anthonomus signatus* SAY.)

Strawberry weevils are small, reddish-brown snout beetles from $\frac{1}{12}$ to $\frac{1}{8}$ inches long. They feed on the stems of the buds causing them to wilt and hang on partly severed stems, or to drop to the ground (see illustration). With a heavy attack a large number of the blossoms will be destroyed thus reducing the crop. Damage is more likely to occur in patches with rough headlands, near brush piles, or wooded areas as these conditions afford excellent winter quarters for the beetles.

Control — (1) Plant strawberries as far as possible from woods or waste land. Keep the headlands and surroundings free from weeds and rubbish. Set new plantations as far as possible from old ones.

(2) Sprays and dusts. Spray with 50% DDT wettable powder 2 pounds in 100 gallons of water or dust with 3 or 5% DDT when the first blossoms appear. One treatment is usually all that is required. The DDT may be combined with a fungicide if it is required for disease control.

STRAWBERRY LEAF BEETLE (*Paria canella* FAB.)

Strawberries are occasionally attacked in the spring and again in the fall by small, stout, glossy-brown, or almost black beetles about $\frac{1}{8}$ inch long. These beetles are seldom seen as they feed at night. They eat small holes in the leaves, often completely riddling them. Their larvae are tiny, white grubs which feed on the rootlets and occasionally cause damage. As a rule neither beetles nor grubs are abundant enough to be important.

Control — (1) Plough down infested plantings and cultivate the soil immediately after the crop is harvested. Set new plantings as far as possible from old ones and, if possible, away from wooded or other areas that provide shelter for the overwintering beetles.

(2) If the beetles are seen in time in the spring or if they attack in the fall, spray with lead arsenate 5 pounds in 100 gallons of water. DDT also is claimed

to be effective against this pest used at the same rate recommended for the strawberry weevil. Do not use either lead arsenate or DDT from the bloom period until the harvest is completed.

CYCLAMEN MITE (*Tarsonemus pallidus* BANKS)

Cyclamen mites are pale in colour and so small that they are difficult to see without the aid of a hand lens. They are primarily a pest on greenhouse plants but will attack strawberries. They feed on the young leaves as they unfold from the crown of the plant and later on the blossoms. Blossom feeding may cause distortion of the fruit. There have been a few reports of damage from this pest in Ontario.

Control — Control by chemicals in the field is difficult although some new chemicals are promising. Use mite-free plants when setting new plantations.

CUTWORMS

Several species of these insects attack strawberries. They are stout, smooth, greasy-looking, dull-colored caterpillars, about 1½ to 2 inches long when full-grown. The adults are stout, dull-colored moths which fly at night. They are commonly known as “millers.” The caterpillars attack the plants late in the evening and during the night and cut off the stems at the ground or eat the leaves. By day the cutworms lie curled up and hidden beneath rubbish, or just under the surface of the soil.

Control — (1) by the use of poison bran bait. A good formula is:

Bran.....	100 lb.
Paris green.....	4 lb.
Water to moisten, or about	10 gal.

Mix the bran and paris green **very thoroughly** while dry by shovelling over the mixture on a concrete floor. Then add the water gradually to the poisoned bran while shovelling until all is mixed. Scatter the bait by hand over the plants on a warm evening. The above amount should treat an acre.

One of the following poisons may replace paris green in the above formula: aldrin, chlordane, DDT, dieldrin, heptachlor, and toxaphene. Consult the manufacturer’s label or circulars on cutworms for rates.

Caution in Using Insecticides

All the materials recommended in this bulletin for insect control are poisonous. Parathion and TEPP are deadly poisons. Follow all the precautions given by the manufacturer concerning the safe use of insecticides.

STRAWBERRY DISEASES

C. B. Kelly, Dept. of Botany, O.A.C., Guelph

The grower should consult the current Ontario Protection Calendar for Small Fruits for the most recent recommendations on spraying and dusting to control disease. The materials mentioned in the following sections are those in use at the time of publication.

BLACK ROOT (ROOT ROT)

Black root is responsible for poor stands and low yields in many plantings. It has been shown that a number of soil fungi can attack strawberry roots and are part of a complex responsible for the disease. Soil conditions may be partly responsible, since it has often been observed that black root has started in, and spread from the low, wet areas of a field. Similarly, in some soils nematodes (microscopic worms) damage the roots and make wounds through which fungi can readily gain entrance. Winter injury and damage to roots by frost heaving may add to the damage and make it easier for the rot fungi to invade the roots. In Ontario, winter injury alone is not the cause of the trouble, for the condition also is found in runner plants during the summer.

Symptoms — Affected plants are generally stunted. When the berries are about half-grown the plants frequently wilt and die. If the roots of such plants are examined, some will be found to be blackened and dead; others show blackened areas and there may be a marked lack of fibrous roots. If the crown is cut lengthwise and shows considerable discoloration in the basal part, it is very likely that winter injury has contributed to the damage.

Control — While no completely effective control has been devised yet, good cultural practices will do much to reduce losses from the disease. In selecting a site for a new planting, choose a warm, well-drained soil, and a field where strawberries have not been grown for at least four years. A soybean green-manure crop preceding the strawberries has been found helpful. Plant stock with vigorous, healthy, white or cream colored roots. Obtain the plants, if possible, from a planting free of black root and winter injury. The use of a mulch during the winter will help to avoid winter injury and heaving.

The effect of other crops in the rotation on the population of harmful nematodes is not known. It is possible that the solution to the problem on some soils may be the application of a soil fumigant. This work is still in the experimental stage.

GREY MOULD

In wet seasons, the *Botrytis* fungus causing this rot is responsible for serious losses in the field and later during shipment. Heavy foliage induced by excessive applications of nitrogen fertilizer, and weeds in the rows provide ideal conditions for grey mould since the fungus thrives under humid conditions. Grey-mould disease has increased in importance following wider use of sprinkler irrigation.

Symptoms — Both green and ripe fruits are affected. The rot appears first as a light brown spot and soon spreads over the whole fruit. The rotted fruits dry and are covered with a fine, grey, powdery growth of the fungus. Flowers may be blighted and flower stalks may be attacked by the fungus.

Control — Spraying with 50% captan wettable powder 2 pounds in 100 gallons of water or dusting with 7½% captan dust has provided good control. About 200 gallons of spray or 55 to 60 pounds of dust is required per acre. The applications should start when the first blossoms open and be repeated every five to seven days until picking starts. It is important to pick and pack sound fruit only, since the disease may continue to spread during shipment.

The application of nitrogen fertilizer to a bearing planting, early in the spring, tends to promote a vigorous growth of foliage that may encourage an outbreak of grey mould. By delaying the application until the first blooms open, it may be possible to avoid overstimulating the leaves and still give the desired stimulus to fruit production.

RED STELE

In Ontario, this root disease has been found only on one farm in the Niagara fruit belt. Elsewhere, it has caused very serious losses. Red stele is caused by a fungus, *Phytophthora fragariae*, that is capable of surviving for a number of years in the soil. It thrives in poorly-drained, cold, wet soil and in the low spots in a field. The strawberry is the only plant known to be affected.

Symptoms — Affected plants generally appear stunted and unthrifty compared to nearby healthy plants. In the spring the young leaves are small, short-stemmed and usually have a bluish-grey cast, while the older leaves wilt, turn brown and die. Severely affected plants frequently wilt and die during the picking season. The disease may be confirmed by an examination of the roots in the spring. If cut lengthwise, the diseased roots show a red to reddish-brown discoloration of the stele or central core of the root. This red discoloration may be present in all or only a few roots and may be present only for a short distance above the blackened root tip or extend the whole length of the root. The crown is not affected. In plants affected by black root the lateral or fibrous roots are often absent, and the roots are black or dark brown with a white stele, except in advanced cases where the core is black but never red as above.

Control — A grower should take every precaution to keep red stele from his farm. New plants should be obtained from plantings known to be free of the disease. Accepting plants, that appear to be healthy, from a planting where the disease occurs is unwise since the selected plants may be infected but not yet showing the symptoms.

In selecting a new site for strawberries, avoid heavy soils and soils having poor surface or internal drainage. Do not plant the low spots where water tends to lie in the spring, fall or winter.

On infested soil one must resort to growing red stele-resistant varieties, and since there are strains of the fungus, varieties that are resistant in other areas may not all prove to be resistant here. It also will be necessary to select varieties suited to Ontario conditions and market preferences. A number of resistant varieties are Sparkle, Temple, Fairland, Pathfinder and Red Crop. The variety Premier is susceptible.

VERTICILLIUM WILT

Although Verticillium wilt has been found widely distributed in the Province, it does not appear to be an important disease at present.

Symptoms — The first noticeable symptom is a wilting of the outer leaves. This most commonly occurs after the fruit begins to ripen. Soon most of the plant is affected, the older leaves dry and turn brown, and the plant succumbs quickly or dies slowly after producing a few weak leaves from the center of the crown. The disease may be mistaken for white grub injury. The latter is readily identified by the presence of grubs or signs of feeding on the roots or crown.

Control — The disease is caused by a soil fungus, *Verticillium albo-atrum*, that invades the roots and interferes with the movement of water to the leaves. Since the same fungus attacks potatoes, tomatoes, peppers and eggplants, it would be well to avoid planting strawberries following these crops. Wilted plants in a new planting should be removed and destroyed.

JUNE YELLOWS

June yellows is not infectious. It is believed to be due to an hereditary character.

Symptoms — Young leaves show a faint streaking and mottling of yellow or cream and green. As the affected leaves develop, the green colour diminishes and finally the leaves become golden or light yellow with little or no green. Badly affected plants are stunted, produce little or no fruit and finally die. With the arrival of hot weather the yellow coloration gradually disappears from the planting and by mid-July it may have a normal green colour. However, diseased plants do not recover. They show the same yellowing the following spring and all the runner plants they produce are affected.

Control — Certain stocks or strains of Premier are comparatively free from June yellows and these should be planted if possible. Roguing affected plants has been found ineffective in keeping the disease in check. Normal plants of susceptible varieties possess the character for yellowing, and there is no way of telling when a plant or its progeny may develop the disease.

POWDERY MILDEW

Powdery mildew is seldom widespread in occurrence, but may be very destructive locally. It is caused by the fungus *Sphaerotheca humuli*.

Symptoms — The affected leaves curl upward exposing the under side on which can be seen the white, powdery growth of the fungus. In severe attacks the leaves become dry, and the plants may die. If a severe outbreak occurs before picking time, there may be a complete loss of crop.

Control — At the first appearance of powdery mildew, dust the under side of the leaves with a 15-85 copper-lime dust. Repeat the application at intervals of ten to fourteen days until the disease is under control. The bordeaux spray applied to control leaf spot and scorch also helps to control mildew. Sulphur dust is very effective, but pickers object to sulphur on the foliage and there is danger of severe damage to leaves if the weather is hot.

LEAF SPOT

Leaf spot is a disease of minor importance in Ontario because Premier, the principal variety, is resistant. Such varieties as Sparkle, Temple, Valentine, Parsons, Dunlap and Glen Mary are susceptible. The disease is caused by the fungus *Mycosphaerella fragariae*.

Symptoms — The spots are small and reddish or purplish at first. They enlarge, the centres become grey or whitish with a reddish or purplish border. If the spots are numerous the leaves may be killed, the plants weakened, and yield reduced. Spots may also occur on the leaf stems, fruit stalks, and runners.

Control — Secure planting stock free of the disease, or trim off the spotted leaves. Spray new plantings with bordeaux 5-5-100, or with 50% captan wettable powder 2 pounds in 100 gallons of water at the first sign of disease. Bearing plantings of susceptible varieties should be sprayed in the spring when growth is well started, and again when the first blossoms appear. Frequent rains or dews, before bloom, favour an outbreak of leaf spot. New growth is especially susceptible. Plantings that are to be cropped again the following year may be mowed after picking and should be sprayed to protect the new growth against infection.

The practice of cropping strawberries for only one or two seasons has probably helped considerably in keeping foliage diseases under control.

LEAF SCORCH

Leaf scorch becomes prevalent in midsummer, the mature leaves being especially susceptible to attack. It is seldom serious in the first year of the planting. The disease is caused by the fungus *Diplocarpon earliana*.

Symptoms — In its early stages scorch is easily mistaken for leaf spot. However, when the spots enlarge they do not develop the white centres typical of the leaf spot disease. The spots often coalesce to form large, irregular, purplish blotches, and in severe cases entire leaflets become dry and scorched. Infections on leaf stems may girdle them and result in the death of the entire leaf. Fruit stalks and stolons may also be affected.

Control — The control measures outlined for leaf spot also control scorch. The variety Premier is fairly resistant to scorch.

LEAF BLIGHT

This disease sometimes appears in old plantings after harvest. The disease is caused by the fungus *Dendrophoma obscurans*.

Symptoms — Reddish purple, circular spots appear on the leaves. In the early stages, blight may resemble leaf spot and scorch. As the spots enlarge, the central portion dies and turns brown. Often the blighted areas on the leaf are oval- to wedge-shaped. Usually blight is not prevalent until late summer or fall. The varieties Dunlap, Robinson and Red Crop are susceptible. An old planting of Premier may show considerable blight after harvest.

Control — If this disease becomes a problem the control program given for leaf spot should be followed.

VIRUS DISEASES

All commercial stocks of Premier in Ontario appear to be virus-infected, but this has not affected yields appreciably. All runner plants produced by a diseased mother plant carry the virus, and the strawberry aphid may transfer it to other plants of the same or a different variety. When aphids inoculate, with a second virus, plants already carrying one virus, severe symptoms and a marked reduction in yield may occur.

Lately some growers have been interested in obtaining virus-free stocks of a number of varieties for comparison with Ontario-grown Premier. Many of them are not as tolerant of viruses as Premier. They will become virus-infected when planted beside varieties not free of viruses. How long they will maintain their vigour and productiveness remains to be seen. It will depend on such factors as the viruses present, and the population of aphids. When setting out new plantings of these varieties, fresh virus-free stock should be brought in.

Nurserymen who wish to propagate virus-free stock should isolate it from other strawberries, and follow a regular schedule of parathion or malathion dusts, or sprays, to keep strawberry aphids under control.



rev 1963

LET'S COOK IT

Right

CAZONAF6
B514



NUTRITION SECTION

HOME ECONOMICS SERVICE, EXTENSION BRANCH

NTARIO DEPARTMENT OF AGRICULTURE

LIAMENT BUILDINGS

TORONTO, CANADA

Let's Cook It Right!



Let's Cook It Right!

Table of Contents

	PAGE
BEVERAGES - - - - -	87
CAKES - - - - -	63
CAKE FROSTINGS - - - - -	70
CHEESE - - - - -	44
COOKIES - - - - -	78
DESSERTS - - - - -	55
EGGS - - - - -	40
FISH - - - - -	31
FRUIT - - - - -	52
MEAT - - - - -	17
MUFFINS - - - - -	76
PASTRY - - - - -	80
POULTRY - - - - -	35
SALADS - - - - -	12
SAUCES - - - - -	34
SOUP - - - - -	48
TEA BISCUITS - - - - -	74
VEGETABLES - - - - -	8

THE NEW YORK PUBLIC LIBRARY

ASTOR LENOX TILDEN FOUNDATION

1215 Broadway
New York, N. Y.
10021-2143
Tel. (212) 854-2400
Fax (212) 854-2401
www.nypl.org

Let's Cook It Right!

LET'S cook it right! Now there's a challenge for the modern homemaker. We all know that there is a right way and a wrong way to do things. Are we cooking and baking the right way according to modern methods? Have we streamlined our kitchen thinking and discarded all our "old wives' tales"?

Modern science has helped to show us the best ways of cooking for speed, efficiency and saving food values. Ideas have changed in the last few years. Have we changed with them? Do we store our opened tinned goods in the original tin? It's the smart thing to do! We save on space and dishwashing. Do we boil our vegetables in a small amount of water in a covered container? Vegetables boiled in this way taste so much better and are better for us. Do we use low temperatures for roasting meats, or do we still sear the roast in a red hot oven? It pays to remember that a red hot oven causes great shrinkage in a roast.

Let's check on our cooking methods. We can begin right now by turning over this page.

What do we Cook?

Before we start discussing the most up-to-date methods of cooking, there is a preliminary question we must answer.

What foods should we be cooking?

We have all known for a long time that health depends on the *kind* of food we eat.

Chickens, pigs and cattle do not develop equally well on just *any* kind of food. Neither do human beings.

TO COOK FOODS FOR HEALTH, KEEP YOUR EYE ON

Food Guide For Health

*These foods are good to eat.
Eat them every day for health.
Have at least three meals each day.*

1. MILK

Children (up to about 12 years): at least 1 pint.

Adolescents: at least 1½ pints.

Adults: at least ½ pint.

2. FRUIT

One serving of citrus fruit or tomatoes or their juices; and one serving of other fruit.

3. VEGETABLES

At least one serving of potatoes; and at least two servings of other vegetables, preferably leafy, green or yellow and frequently raw.

4. CEREALS AND BREAD

One serving of whole grain cereal, and at least four slices of bread with butter.

5. MEAT AND FISH

One serving of meat, fish, poultry, or meat alternates such as dried beans, eggs and cheese.

Use LIVER frequently.

In addition:

EGGS AND CHEESE

at least three times a week each.

VITAMIN D

At least 400 International Units daily for all growing persons and expectant and nursing mothers.

Meal Planning



To make sure your family is getting foods needed for health, it is wise to plan meals centred around the **FOOD GUIDE FOR HEALTH**. Every day include foods from each of the food groups. Remember the five groups on page 4. They are milk, fruits, vegetables, cereals and meat or the alternates of meat.

After these health-giving foods have made a "home run" in your meal plan, pies, cakes, cookies and other sweets may be added.

Although selection of the **RIGHT** foods comes **FIRST** in meal planning, think of contrasts in colour, flavour, texture and temperature, too!

COLOUR calls forward our whole-hearted interest in a meal by tempting the appetite. Vegetables, fruits and salads carry the flag in the colour parade. In addition they supply those all-important minerals and vitamins.

FLAVOURS give a "punch" to meals. So try out new herbs, seasonings and flavourings. To provide taste contrasts serve together sweet and sour, spicy and bland foods.

Plan for **TEXTURE** contrasts in every meal. Just think of the many kinds of crisp, smooth and chewy foods you can serve together to carry out this meal planning secret.

Include foods of different **TEMPERATURES** at each meal. A whole meal of hot foods is monotonous. Contrasts of hot and cold supply variety and interest. Remember to serve hot foods hot and cold foods thoroughly chilled.

LET'S PLAN IT RIGHT—THEN COOK IT RIGHT!



To measure liquid accurately, place a standard measuring cup on a level surface. If you hold the cup in your hand it may slant and an inaccurate measurement result.

Guide to Successful Right Cooking

Use standard measuring cups and spoons. It is not economy to save cents on this simple equipment and waste food because of cooking failures. All good modern recipes are based on standard measurements.

For good results every time, measure exactly. Measurements must be level.

Use the blunt edge of a knife to level your measurements.

See "Measurement of Ingredients", pages 63 and 64.

Good utensils save time, may prevent cooking failures and often will save food value too. The size of pan required for each recipe is generally stated in the method of the recipe.

Budget to replace out-of-date utensils with efficient equipment. There is a lot of common sense in the old saying, "Neither wise men nor fools can work without tools".

MEASUREMENT ABBREVIATIONS

cup	.....	c.
teaspoon	.....	tsp.
tablespoon	.....	tblsp.
pint	.....	pt.
quart	.....	qt.
ounce	.....	oz.
pound	.....	lb.
few grains	.....	f.g.

MEASUREMENTS

3 tsp.	.....	1 tblsp.
16 tblsp.	.....	1 c.
1 c.	.....	8 oz.

OVEN TEMPERATURES

Slow oven	.....	250°-350°
Moderate oven	.....	350°-400°
Hot oven	.....	400°-450°
Very hot oven	.....	450°-550°

Do You Cook It Right?

1. To save vitamins and flavour, serve vegetables as soon as they are cooked. See page 9.
2. Always start cooking vegetables in boiling water. See page 8.
3. Always save vegetable stock to make stews, gravies and soups. It contains minerals and vitamins and will also add flavour. See page 9.
4. Salad greens may be kept crisp if washed and then wrapped in a damp cloth, waxed paper or paper bag and stored in a cold place. See page 12.
5. Meat cooked at a low temperature is juicier than meat which is seared. See page 17.
6. The braising method of cooking meat is used for pot roasts, Swiss steaks, veal chops, pork chops, etc. A small amount of liquid may be used and the cooking vessel should have a close fitting lid. See pages 23 to 27.
7. Simmering means to cook *under* the boiling point. See page 28.
8. Fish baked quickly keeps its flavour, is juicy and tender. See page 31.
9. Poultry should be roasted in a slow oven, 325°. See page 37.
10. Eggs become tough when they are boiled. See page 41.
11. A high temperature toughens cheese. See page 45.
12. Fruits are the simplest and easiest of all desserts to prepare. Some raw fruits are good sources of vitamin C. See page 52 and page 55.
13. Ingredients for cakes should be at room temperature. See page 64.
14. "Butter-type" cakes should remain in the pan 10 minutes after removal from the oven. See page 69.
15. Kneading the dough for 1 minute, after mixing, improves tea biscuits. See page 74.
16. Muffin batter should be mixed as little as possible. See pages 76 and 78.
17. Ingredients for pastry should always be cold. See pages 80 and 81.
18. Coffee is best bought in small quantities and stored in an air-tight container. See page 89.

Vegetables

WHEN YOU BUY VEGETABLES

Choose them carefully with an eye to economy and freshness. Avoid limp, wilted vegetables. The fresher the vegetable, the more food value and goodness it contains.

WHEN YOU STORE VEGETABLES

Leave corn in the husks, cauliflower in the green leaves and peas in the pods. These outer coverings protect freshness.

Trim and wash root vegetables. Remove their tops.

Trim and wash leafy green vegetables. The moisture helps keep them crisp and bright. Keep covered in a cold place.

Keep vegetables in a cool, moist dark place for good storage. Exception: onions and dried vegetables should be stored in a dry atmosphere, so they will not pick up moisture and perhaps become mouldy.

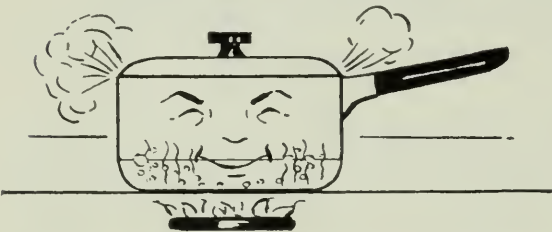
WHEN YOU BOIL VEGETABLES

1. Start cooking vegetables in boiling water.

This is a cardinal rule for well-cooked vegetables. They do taste much better! The vitamins and minerals do not have as great an opportunity for dissolving into the cooking water because a much shorter cooking time is required.

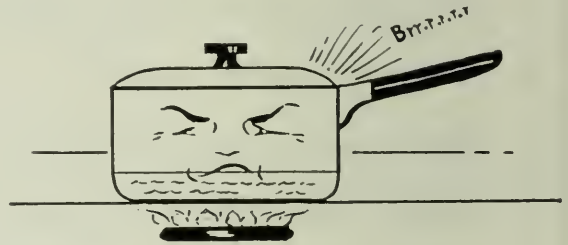
THIS IS RIGHT

Starting in boiling water



THIS IS WRONG

Starting in cold water

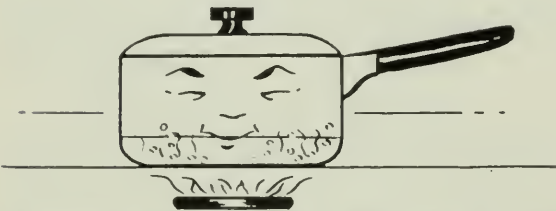


2. Use a small amount of cooking water.

There is less loss of vitamins and minerals into the cooking water when a small amount of water is used. When you use a large amount of cooking water more vitamins are dissolved out.

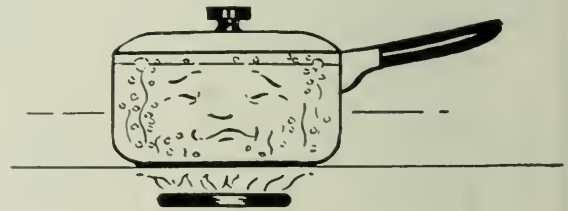
THIS IS RIGHT

Using a small amount of cooking water



THIS IS WRONG

Using large amount of cooking water



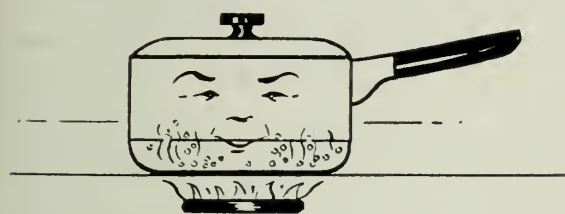
3. Adjust heat to keep water at a gentle rolling boil,

so that the vegetables will not boil dry. Remember you are using only a small amount of water. Rapidly boiling water is the same temperature as gently

boiling water and does not cook the vegetables any faster. Save on fuel by reducing the heat when the water begins to boil.

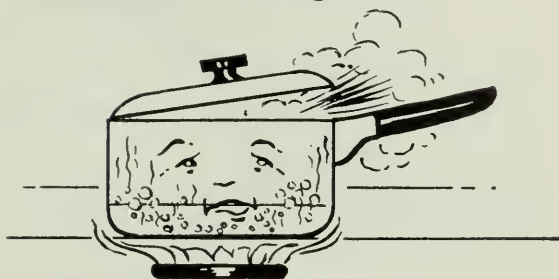
THIS IS RIGHT

*Adjusting heat to keep water
at a gentle boil*



THIS IS WRONG

*Wasting heat by furious
boiling*

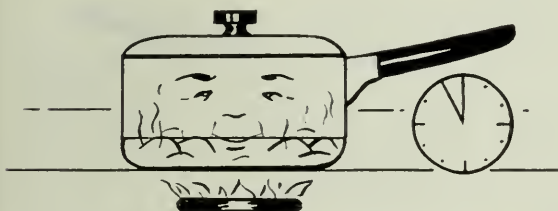


4. Cook vegetables only until they are crisp-tender, not mushy.

Overcooking destroys good flavour, good vitamins and good looks.

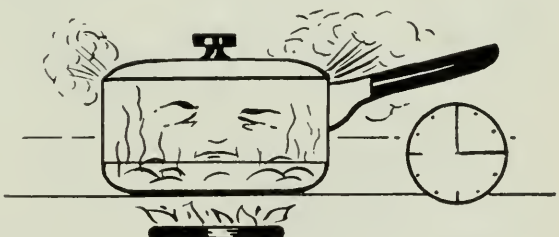
THIS IS RIGHT

*Cook vegetables only until
just crisp-tender*



THIS IS WRONG

Overcooking vegetables



5. Serve vegetables as soon as they are cooked.

Holding vegetables for a long period of time destroys good flavour, good vitamins and good looks.

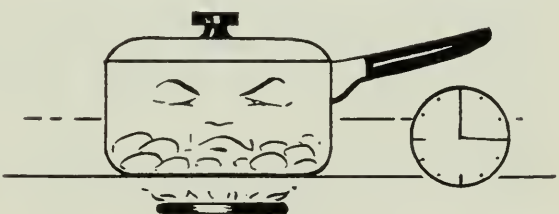
THIS IS RIGHT

*Serving vegetables as soon
as they are cooked*



THIS IS WRONG

*Holding vegetables too long
before serving*

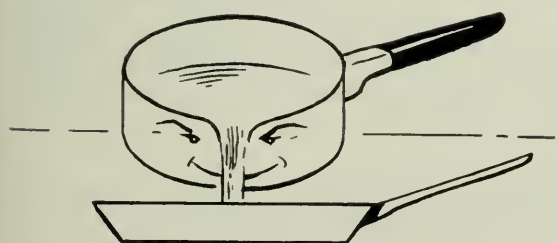


6. Use cooking liquid

for gravies, soups and sauces, as it contains many vitamins and minerals that were in the vegetables. It's too valuable to pour down the drain.

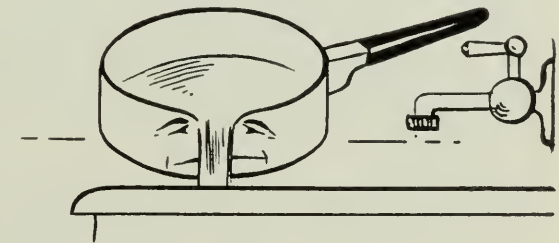
THIS IS RIGHT

*Using cooking liquid
for gravies*



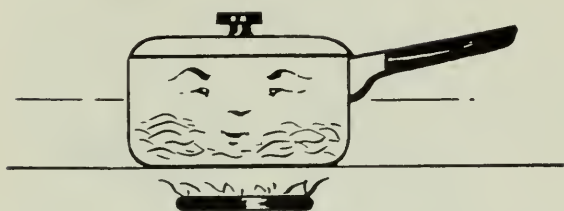
THIS IS WRONG

*Throwing cooking liquid
down the sink*



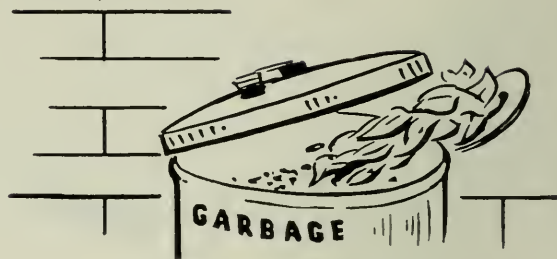
WORTH REMEMBERING

Cook young green tops of vegetables (beet, turnip). You get extra food value and flavour because you are using ALL of the vegetable.



THIS IS RIGHT

Cooking these young green leaves



THIS IS WRONG

Discarding these young green leaves

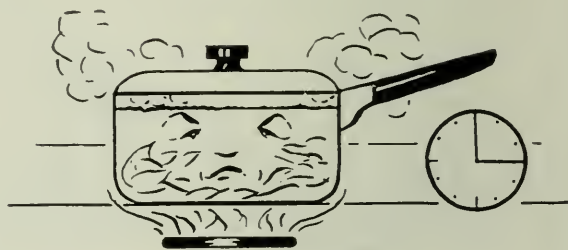
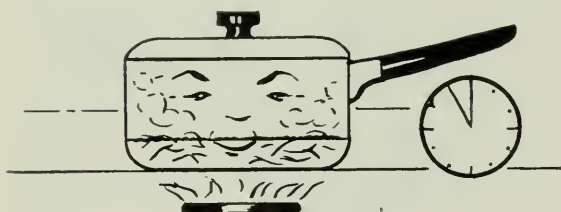
Cooking vegetables properly will retain colour. Overcooking greens usually turns them an unappetizing brown. We know you won't eat them then!

THIS IS RIGHT

*Greens cooked just right
stay nice and green*

THIS IS WRONG

*Overcooked water-soaked
greens turn brown*



For flavour and food value, leave jackets on potatoes during cooking.

One half or more of the ascorbic acid (vitamin C) in boiled potatoes is lost if they are held over and reheated for another meal. Cook only enough vegetables for one meal to save flavour and food value.

One half or more of the ascorbic acid in boiled potatoes is lost if the potatoes are mashed.

HERE'S HOW TO COOK VEGETABLES

1. Boiling

Add vegetables to small amount of vigorously boiling water, ($\frac{1}{2}$ to 1 inch water in saucepan). Cover tightly. Cook until vegetables are just tender. Season. Serve at once.

NOTE. If you have heavy utensils with close fitting lids, you may reduce the amount of water to 2 tbsp.-4 tbsp.

LEAFY GREEN VEGETABLES

Use only the water that clings to the leaves after washing. Cover tightly. Place over moderate heat. Cook until vegetables are just tender. Season. Serve at once.

2. Pressure Cooking

Put prepared vegetables in cooker with small amount of boiling water, $\frac{1}{4}$ c. to $\frac{1}{2}$ c. Cover and tighten seal according to manufacturer's directions. Follow the "Cooking Guide for Fresh Vegetables", page 11, for length of cooking time. With a little experience you will soon learn to judge the cooking times expertly. Season. Serve at once.

3. Baking

Bake all vegetables except potatoes in a moderate oven, 350° . Potatoes require a hot oven, 425° . Bake whole vegetables such as onions and tomatoes, uncovered.

Carrots, beets and parsnips are put in a closely covered greased baking dish with seasoning and sufficient water or fat to keep from drying. Bake until vegetables are just tender.

4. Steaming

Good for mild flavoured vegetables, not so good for strong flavoured vegetables. Place prepared vegetables in perforated pan of steamer over boiling water. Cover tightly. Cook until just tender. Season. Serve at once.

5. Cooking Canned Vegetables

Drain the liquid from the can and heat to boiling. Add vegetables and heat through. Serve at once. Use the liquid in sauce, gravy or soup.

6. Cooking Frozen Vegetables

Cook frozen vegetables, except corn on the cob, without defrosting. Corn on the cob should be defrosted before cooking. Use a small amount of boiling water. Cover. After cooking about 1/2 minute, break up solid block of vegetables. Cook until just tender. Season. Serve at once.

7. Cooking Dried Vegetables

Dried vegetables require soaking to restore water and to soften. The vegetables may be soaked several hours or overnight, and then cooked until tender in the soaking liquid.

COOKING GUIDE FOR FRESH VEGETABLES				
VEGETABLE	BOILING MINUTES	PRESSURE COOKING MINUTES	BAKING MINUTES	STEAMING MINUTES
Asparagus -----	5-15	1-2		
Beans, green or wax, 1" pieces -----	15-30	3-4		30
Beets, whole, new -----	30	15-20		45-60
Beets, whole, old -----	40-60	20	grated 50 at 350°	60-90
Beet greens -----	5-15			
Brussels sprouts -----	8-15	2-3		
Broccoli, cut lengthwise -----	8-15	2-3		
Cabbage, wedges (better method of preparation) ---	15	2-4		
Cabbage, finely cut -----	5-10	1-2		
Carrots, small, whole -----	15-20	3-4		20-30
Carrots, large, quartered -----	15-20	2-4	grated 30-40 at 350°	20-30
Cauliflower, flowerets -----	8-10	2		
Celery, 1" pieces -----	15-25	2-3		
Corn on cob -----	5-12	3-5		12
Kale -----	10-20			
Onions, whole -----	20-30	5-7	45-60 at 350°	
Parsnips, quartered -----	20	6-7	grated 30-40 at 350°	30
Peas, green -----	10-20	1-2		25
Potatoes, white, whole -----	20-40	10-15	40-60 at 425°	30-45
Spinach, -----	5-10			
Squash, 1 1/2" cubes -----	20			30
Squash, individual servings ---		4-8	30-60 at 350°	30-60
Sweet potatoes or yams, whole -----	20-45		25-60 at 425°	25-60
Swiss chard -----	5-15			
Tomatoes -----	5-10		20-30 at 350°	
Turnips, white, 1/2" slices -----	10-15	3		
Turnips, yellow, 1/2" cubes -----	20-30	3		

Salads

Tune—"Jingle Bells"

*Let's toss a salad cool,
And ne'er forget the rule,
Always cold and crisp,
It makes you feel so brisk.*

*Crisp and cold, crisp and cold,
Succulent and green;
Oh what fun it is to eat
A salad with esteem!*

A good salad is

1. Crisp
2. Cold
3. Colourful
4. Well-seasoned
5. Pretty as a picture
6. Piled lightly in bowl or on plate

SALAD GARNISHES

Use your own imagination but be careful not to let it run riot. Over decoration can play havoc with a good salad.

Here are a few simple garnishes

1. Sprigs of fresh parsley, mint and watercress
2. Strips of pimiento, red and green peppers
3. Hard-cooked egg, paprika, plain or stuffed olives
4. Radish roses, celery curls
5. Carrot straws, carrot curls
6. Cucumber slices, cooked beets cut in various shapes
7. Salad greens, lettuce leaves, celery leaves

HERE'S HOW TO PREPARE SALADS

1. Use *fresh* fruits and vegetables for salads. Lettuce and salad vegetables may be kept by wrapping in a damp cloth, paper bag or waxed paper. Store in a very cool place.

2. Wash salad greens and examine to be sure they are perfectly clean. Soak in cold water for a short time to crisp, if necessary. Dry on a towel or by draining.
3. All ingredients and dressings should be chilled. It is desirable to chill the bowl and salad plates.
4. Plan to make your salad just before serving.
5. Salad materials should be cut with a sharp knife in uniform, well-defined pieces large enough to prevent loss of shape in tossing. If part of the celery is tough, cut in fine pieces. Cut tender parts in larger pieces. In this way, the toughness will not be detected. When both the dark and light meat of chicken are used, dice the dark in small cubes and the light meat in larger cubes. *Plan to prepare fresh fruits and vegetables for salads the last minute before serving.*
6. Except where the recipe indicates otherwise, add dressing just before serving. Use the least amount of salad dressing.
7. Combine by tossing lightly together.
8. Taste before serving. Note if there is sufficient seasoning. Now is the time to perfect the flavour of that salad. Then the family will not have to add salt and pepper at the table.
9. Mixed green salads may include all types of greens, even outside leaves and celery tops.
10. Serve the salad attractively and don't forget the final touch by adding the garnish.

SALAD ACCOMPANIMENTS

If the salad is to be the main dish of the meal, then you might prefer to serve an accompaniment.

Here are a few suggestions

1. Thin bread and butter
2. Crisp crackers
3. Crackers spread with cheese
4. Sandwiches
5. Melba toast

French Dressing

1¼ c. salad oil
 7 tbsp. lemon juice or cider vinegar

2¼ tsp. salt
 ¼ tsp. pepper
 ½ tsp. paprika
 1 tsp. sugar
 ½ tsp. dry mustard
 1 peeled garlic clove
 3 tbsp. chili sauce (optional)
 1 tsp. horseradish (optional)

1. Mix all ingredients together.
2. Store in covered container in cold place. Shake well before using.

Cooked Salad Dressing

- 1 tsp. dry mustard
- 1 tsp. salt
- 2 tbsps. sugar
- 2 tbsps. flour
- 2 egg yolks, beaten
- 1 c. milk
- 2 tbsps. fat
- $\frac{1}{3}$ c. vinegar

Sweetened Vinegar Dressing

- $\frac{1}{4}$ c. cider vinegar
- $\frac{1}{4}$ c. water
- $\frac{1}{4}$ c. brown sugar
- $\frac{1}{4}$ tsp. salt

Mayonnaise

- 1 egg yolk
- $\frac{1}{2}$ tsp.-1 tsp. salt
- $\frac{1}{2}$ tsp. dry mustard
- $\frac{1}{4}$ tsp. paprika
- f.g. cayenne
- 2 tbsps. vinegar or lemon juice
- 1 c. salad oil

Sour Cream Dressing

- 1 c. thick sour cream
- 2 tbsps. vinegar
- $\frac{1}{2}$ tsp. salt
- f.g. paprika
- 2 tbsps. sugar
- $\frac{1}{2}$ c. sweet pickles, chopped (optional)

Potato Salad

- 4 c. cold potatoes, diced
- 3 tbsps. sweet or dill pickles, chopped
- $\frac{3}{4}$ c. cooked salad dressing
- $\frac{1}{4}$ c. onion, diced
- $\frac{1}{4}$ tsp. celery salt
- $\frac{1}{4}$ tsp. paprika
- 1 tsp. salt

1. Mix mustard, salt, sugar and flour, in top of double boiler.
2. Add beaten egg yolks and milk.
3. Cook over boiling water. Stir until thickened.
4. Add fat.
5. Remove from heat. Cool.
6. Add vinegar slowly.
7. Store in covered container in cold place.

1. Mix vinegar and water.
2. Add brown sugar and salt. Stir until dissolved.
3. Store in covered container in cold place.

1. Put egg yolk and seasonings into bowl and beat thoroughly with Dover egg beater.
2. Add 1 tbsps. vinegar or lemon juice and beat again.
3. Gradually beat in oil, adding $\frac{1}{2}$ tsp. at a time until $\frac{1}{4}$ c. is used.
4. Then add 1 to 2 tbsps. at a time.
5. As mixture thickens, add remaining vinegar or lemon juice.
6. Store in covered container in cold place.

1. Combine ingredients.
2. Store in covered container in cold place.

1. Potatoes should be cooked in their skins, allowed to cool, then skins removed.
2. Combine potatoes and pickles.
3. To salad dressing, add diced onion, celery salt, paprika and salt.
4. Combine salad dressing mixture with potatoes and pickles.
5. Chill and serve.
- Serves 6.

Cabbage, Apple and Raisin Slaw

- 3 c. cabbage, shredded
- 1 c. apples, diced
- 1/2 c. seedless raisins
- 1/2 c.—3/4 c. French dressing

1. Toss chilled cabbage, apples, raisins and dressing in salad bowl.

Serves 6.

Salmon Salad

- 1 c. cold, cooked salmon, fresh or canned
- 1 c. cabbage, shredded or celery, diced
- mayonnaise or salad dressing
- 1/2 tsp. salt
- f.g. pepper

1. Combine flaked salmon, shredded cabbage or diced celery and dressing.
2. Season with salt and pepper to taste.

Serves 4.

Tomato Jelly Salad

- 1 2/3 tbsp. gelatine
- 1/4 c. cold water
- 2 c. tomato juice or strained canned tomatoes
- 1 tbsp. sugar
- 1/2 tsp. salt
- 1/2 bay leaf
- 1/4 c. mild vinegar
- 1 1/2 tbsp. lemon juice

1. Soak gelatine in cold water.
2. Heat 1/2 c. tomato juice, sugar, salt and bay leaf for 5 minutes, covered.
3. Add to soaked gelatine, stirring until gelatine dissolves. Strain if necessary.
4. Add remaining tomato juice, vinegar and lemon juice.
5. Pour into moulds moistened with water, oil or mayonnaise. Chill until firmly set.

Serves 6.

Coleslaw

- 3 c. cabbage, shredded
- 1/2 tsp. salt
- f.g. pepper
- cooked salad dressing or sour cream dressing

1. Toss cabbage, salt, pepper and dressing in salad bowl.

Serves 4-5.

Tossed Salad

- 1 onion, sliced
- 2 c. torn lettuce
- 1/2 c. celery tops
- 1/2 c. celery, diced
- 1/2 c. raw tomato, diced
- 1/2 c. raw parsnips, grated
- 1/4 c. raw turnip, grated
- 1/2 c. raw carrot, grated
- 1/4 c. raw beet, grated
- 1/2 c. French dressing
- OR
- 4 tbsp. lemon juice or vinegar

1. Separate onion slices into rings.
2. Toss all ingredients lightly just before serving.

Serves 6-8.

Jellied Vegetable Salad

BASE

- 1 tbsp. gelatine
- $\frac{1}{2}$ c. cold water
- 1 tsp. salt
- 2 tbsp. sugar
- 1 c. vegetable water
- $\frac{1}{4}$ c. vinegar
- 2 c. vegetables (below)

1. Soak gelatine in cold water.
 2. Add salt and sugar to vegetable water. Heat to boil.
 3. Dissolve soaked gelatine in vegetable water.
 4. Add vinegar.
 5. Cool. When gelatine begins to thicken, add vegetables. See suggested vegetable combinations.
 6. Set in moistened moulds.
- Serves 5.

SUGGESTED VEGETABLE COMBINATIONS

- 1 c. cabbage, shredded
- $\frac{1}{2}$ c. peas
- $\frac{1}{2}$ c. cooked carrots, diced
- $\frac{1}{2}$ tbsp. pickles

OR

- 1 c. cabbage, shredded
- $\frac{1}{2}$ c. cooked carrots, diced
- $\frac{1}{2}$ c. celery, diced

Ambrosia Salad

- $\frac{1}{4}$ c. Fruit Dressing (below) mixed with
- $\frac{1}{2}$ c. whipped cream
- $\frac{3}{4}$ c. orange, sectioned
- $\frac{3}{4}$ c. grapefruit, sectioned
- $\frac{1}{4}$ c. dates or raisins
- $\frac{1}{2}$ c. apple, diced
- 1 banana, diced

1. Mix fruit dressing with whipped cream.
 2. Toss fruit lightly together just before serving.
 3. Combine fruit and dressing immediately.
- Serves 5-6.

Fruit Dressing

- 2 tbsp. flour
- 2 tbsp. sugar
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{3}$ c. marmalade
- 1 c. water
- 1 tsp. orange rind, grated
- 2 eggs
- 2 tbsp. lemon juice
- 2 tbsp. orange juice

1. Mix dry ingredients in top of double boiler.
2. Mix marmalade, water and orange rind and add to dry ingredients.
3. Cook and stir over direct heat until thick and no taste of raw starch.
4. Add to beaten eggs. Cook 5 minutes longer over boiling water.
5. Remove from heat. Add fruit juices.
6. After chilling, store in covered bottle in a cold place.

Meat

Properly cooked meat is juicy, tender and well-flavoured.

WORTH REMEMBERING

Using too high a temperature in cooking meat results in meat that is tough, stringy and dry. Remember to use slow to moderate temperatures for meat.

HERE'S HOW TO SELECT MEAT

1. When you buy

Beef is graded. **CHOICE** quality beef has a red stamp on the carcass. **GOOD** quality beef has a blue stamp on the carcass.

2. Whether buying or using your own meat

A good quantity of fat on the outside of the cut of meat is desirable. Well-finished carcasses have streaks of fat throughout the lean.

3. Know how many servings to expect from a pound

- (a) Much bone or gristle
1 lb. yields 1-2 servings or less.
- (b) Medium amount of bone
1 lb. yields 2-3 servings.
- (c) Little bone
1 lb. yields 3-4 servings.
- (d) No bone
1 lb. yields 4 servings.

Well-cooked meat is

- 1. Juicy
- 2. Tender
- 3. Full of good meat flavour

HERE'S HOW TO KNOW THE BEST METHODS FOR COOKING EACH CUT

I. ROASTING

Cuts to roast

Beef: ribs, loin.

Veal: leg, loin, shoulder.

Lamb: leg, shoulder, crown.

Pork: *Fresh:* loin, shoulder, leg or ham, spareribs.

Smoked: ham, picnic shoulder, shoulder butt.



In roasting, place meat fat side up on rack in open roasting pan. Insert meat thermometer. Do not add water. Use a slow oven, 325°.

How to roast

1. Wipe meat with a clean damp cloth.
2. Place meat fat side up on a rack in an open pan in slow oven, 325°.
3. Do not add water. Do not cover pan.
4. A meat thermometer is the only true test of doneness. The approximate roasting time in Roasting Chart, page 19, is a guide only. Size, shape, fat covering and initial temperature of meat influence length of cooking period.
5. Insert meat thermometer into thickest part of meat, not touching fat or bone.

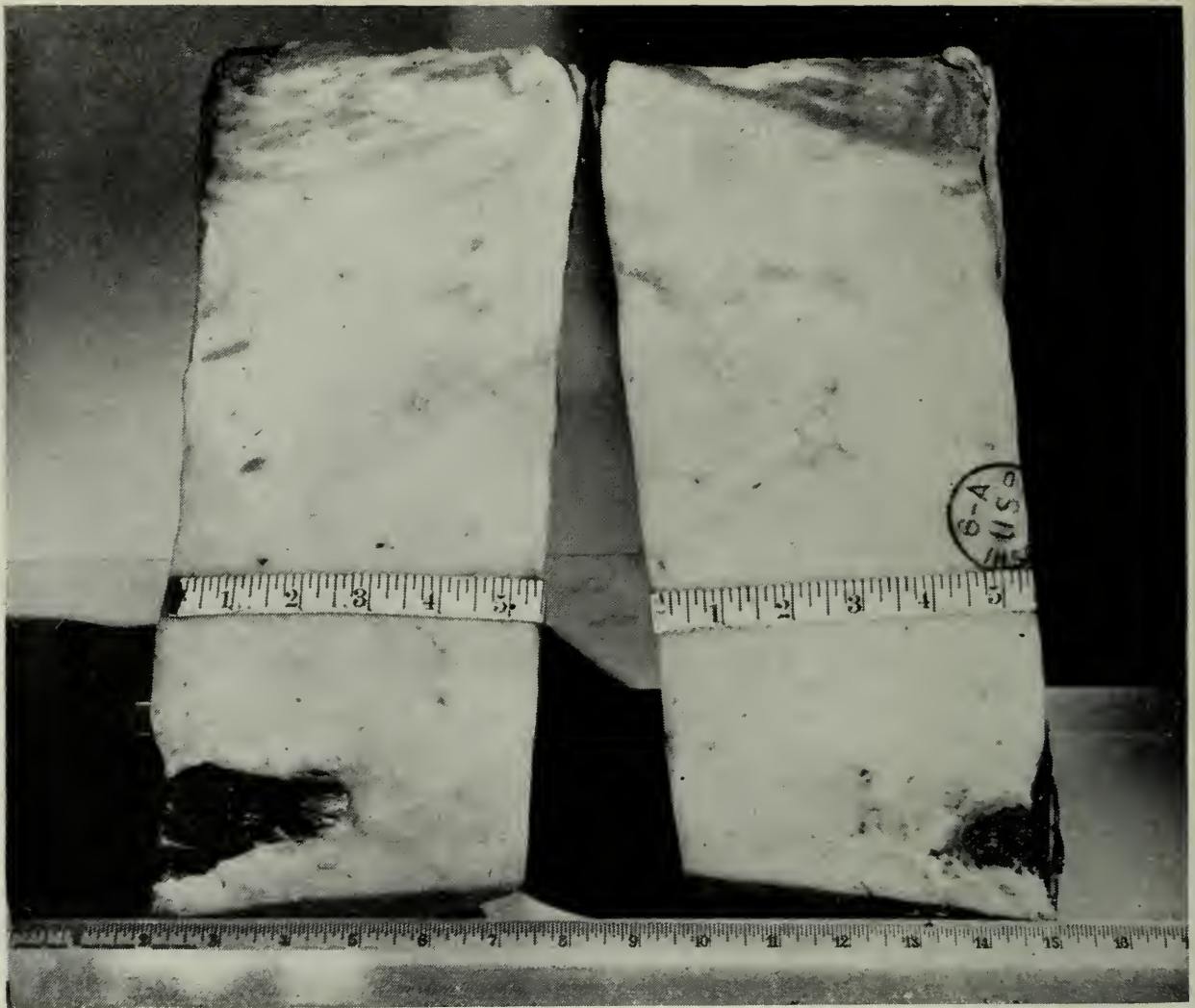
NOTE FOR FROZEN ROASTS

1. Roasts cook more evenly if they are thawed before roasting. However, meat may be cooked from frozen state. Allow an additional 10-20 minutes per pound when cooking a frozen roast.
2. To thaw meat at room temperature allow 2 hours per pound of meat. Leave in wrapping.
3. To thaw a 4 lb. roast in the refrigerator allow 24-36 hours. Leave in wrapping.
4. Cook meat immediately after thawing. Do not refreeze thawed meat.

MEAT ROASTING CHART

OVEN TEMPERATURE 325°

	APPROXIMATE COOKING TIME HOURS			INTERNAL TEMPERATURE
Beef	4 lb.	6 lb.	8 lb.	
Standing ribs				
Rare -----	1¾	2¼	3	140°
Medium -----	2	2½	3½	160°
Well done -----	2⅓	3⅓	4½	170°
Rolled ribs				
Rare -----	2¼	3		140°
Medium -----	2½	3⅓		160°
Well done -----	2¾	4		170°
Lamb—Well done	3 lb.	8 lb.		
Leg -----	3½	4		182°
	3 lb.	5 lb.		
Crown -----		3¾		182°
Shoulder -----	1¾	3		182°
Shoulder, boned and rolled -----	2	2½		182°
Veal—Well done	4 lb.	5 lb.	8 lb.	
Leg -----		3⅓	4	180°
Loin -----		3	4	180°
Shoulder -----		3⅓	4⅔	180°
Shoulder, boned and rolled -----	2⅔		4	180°
Fresh Pork—Well done	5 lb.	8 lb.	10 lb.	
Leg -----	4¼	5⅓	6½	185°
Loin -----	3⅓			185°
Shoulder -----	3⅓	5		185°
	4 lb.	6 lb.		
Shoulder, boned and rolled -----	3⅔	4⅔		185°
Shoulder butt -----	3⅓			185°
Cured and Smoked Pork	9 lb.	11 lb.	13 lb.	
Ham (leg) -----	3	3¼	3½	150°
	4-6 lb.	6-8 lb.		
Picnic shoulder, hockless -----	2-3	3-3¼		170°
	3-5 lb.	5-7 lb.		
Picnic shoulder, boneless -----	2¼-3¾	3-4		170°
Shoulder, cottage style -----	2¼-3¾	3-4		170°



These paired roasts were exactly alike in weight and measurement before roasting. The effects of cooking these roasts at different oven temperatures are shown in the photographs on page 21.

LET'S COOK OUR ROASTS RIGHT

OVEN TEMPERATURE MAKES A DIFFERENCE

Wrong

Disadvantages of meat roasted at a high temperature

1. Shrunk fibres
2. Fat and bones charred
3. Unevenly cooked
4. Less tender
5. Dry
6. Excessive shrinkage
7. Much attention required
8. Hot kitchen
9. Much spattering of oven
10. Greater fuel consumption

Right

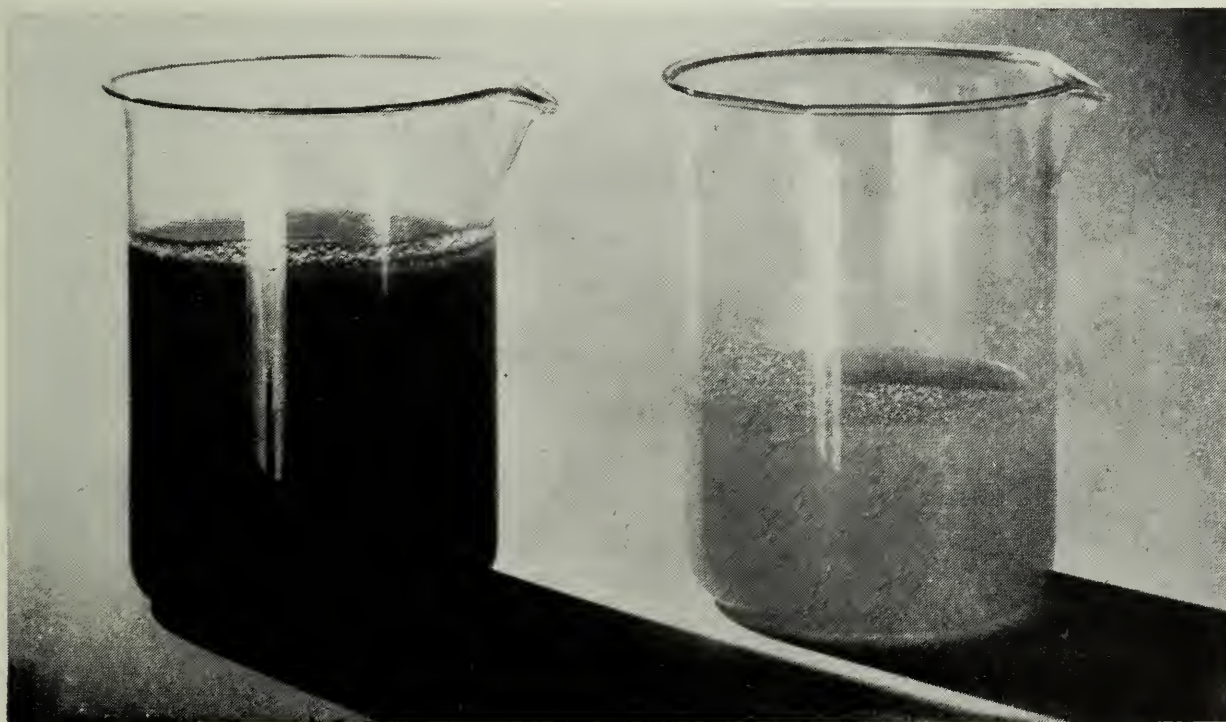
Advantages of meat roasted at a low temperature

1. Fibres plump and full
2. Nicely browned
3. Evenly cooked throughout the slice
4. Tender
5. Juicy
6. Minimum shrinkage
7. Little attention required
8. Cool kitchen
9. No spattering of oven
10. Low fuel consumption



Roast at left was cooked at TOO HOT A TEMPERATURE. The result is greater shrinkage and cooking losses.

Roast at right was cooked IN A SLOW OVEN. Note plump, juicy appearance of roast and larger number of servings available.



Note appearance and difference in amounts of drippings from roasts cooked at too high temperature (left) and slow oven (right). To cook it right, use a slow oven for your roast.



*Broil meat 3 to 5 inches from the source of heat. Turn when meat is well browned and cooking time for one side is completed. See Broiling Chart, page 23.
Broiled ham and peaches are delicious.*

II. BROILING

Cuts to broil

Beef: steaks (ribs, club, tenderloin, porterhouse, T-bone, sirloin), patties

Veal: calves' liver.

Lamb: chops (shoulder, rib, loin), patties, liver, kidney.

Pork: Smoked: slice of ham or picnic shoulder, bacon.

NOTE

1. Oven-broil steaks and chops cut 1 to 2 inches thick.
2. Pan-broil steaks and chops cut less than 1 inch thick.
3. Thin cuts which are frozen may be cooked unthawed. An additional 20-30 minutes is required over the time suggested in Broiling Chart, page 23.

How to oven-broil

1. Preheat broiler.
2. Slash edges of fat in several places to prevent curling.
3. Place meat on greased broiler rack so that surface of meat is 3 to 5 inches from heat source. Leave oven or broiler door partly open.

4. Broil until one side is browned. See Broiling Chart (below) for approximate cooking times.
5. Turn meat and brown other side. Do not prick meat with fork because this releases meat juices.
6. Season both sides of meat. Serve at once on hot platter.

BROILING CHART

		APPROXIMATE TIME PER SIDE IN MINUTES		
		1 INCH THICK	1½ INCH THICK	2 INCH THICK
BEEF				
Steaks				
Rare		5	9	16
Medium		6	10	18
Well done		7	12	20
Patties	10			
LAMB				
Chops—Well done		7	11	
PORK				
Ham and picnic shoulders				
Uncooked slices		10		
Bacon	4			
LIVER (calves' and lamb)				
½ inch thick, brushed with melted fat	10			
KIDNEY (veal and lamb)				
Split open, brushed with melted fat	7			

III. PAN-BROILING

Cuts to pan-broil. See "Cuts to broil", page 22.

How to pan-broil

1. Heat frying pan. Rub lightly with fat.
2. Brown meat on both sides. Do not prick meat with fork while turning it. Pricking releases meat juices.
3. Reduce heat. Turn meat as needed to cook and brown evenly. See Broiling Chart (above), for approximate cooking times.
4. Do not add fat or water. Do not cover pan.
5. When meat is done, season and serve at once.

IV. BRAISING

Cuts to braise

- Beef:* pot roasts (blade, rump, brisket, heel of round, chuck), short ribs, round or chuck steak, flank steak, stuffed steak, heart, kidney, liver, oxtails.
- Veal:* breast, shoulder, rib or loin chops, steaks or cutlets, heart, kidney.
- Lamb:* breast, shoulder, neck slices, shanks, heart.
- Pork:* *Fresh:* shoulder steaks, rib or loin chops, spareribs, tenderloin, hocks, heart, kidney, liver.



Swiss steak with onion rings. A less tender cut of beef made tender by long, slow cooking at simmering temperature. See recipe, page 29.



Cut fat edge of pork chops, or other thin cuts of meat, to prevent curling during cooking.

BRAISING CHART

	WEIGHT	APPROXIMATE COOKING TIME AFTER BROWNING
	LB.	HOURS
Beef		
Pot roast	3	3
	5	3½
Round or chuck steak (Swiss) 1-1½ inches thick	2-3	2½
Flank steak (may be stuffed)	1½-2	2
Short ribs		2
Shank, 2 inch pieces		2
Brisket		3
Oxtails		3
Liver, ½ inch slices		½
Heart	3-3½	2½
Lamb		
Shoulder, boned and rolled	2-3	2
	4-5	2½
Shank	¾-1¼	2
Shoulder chops, ½ inch thick		½
Heart	¼-½	1
Breast	1½-2	2
Veal		
Shoulder, boned and rolled	2-4	3
Loin or rib chops, ½-¾ inch thick		¾
Steak or cutlets, ½-¾ inch thick		1
Breast	2-3	2
Pork		
Rib or loin chops, 1 inch thick		¾
Spareribs		2
Tenderloin, whole	¾-1	1
½ inch slices		½
Liver, ½ inch slices		½
Heart	½	1½
Shoulder steak		½



Pictures Show Steps in Preparing a Braised Roast with Vegetables

(1) Brown meat thoroughly in hot fat for 20 to 30 minutes. Add a small amount of liquid and seasonings. Cover pot and let meat simmer over low heat about 3 hours or until meat is tender.



(2) Thirty to forty minutes before meat is done, add vegetables.



(3) Braised blade roast with vegetables ready to serve. Be sure to use all the cooking liquid in well-seasoned gravy.

How to braise

1. Season meat. Dip in seasoned flour, if desired. Thin cuts of tough meat may be pounded with edge of plate before browning. Pounding helps to tenderize meat.
2. Brown meat in fat in frying pan.
3. Simmer (cook below boiling point) on top of stove or in a moderate oven, 350°. Some liquid is usually added. This liquid may be vegetable water, tomato, milk, cream or water; $\frac{1}{4}$ c.- $\frac{1}{2}$ c. Add more if required. Cover tightly.
4. See Braising Chart, page 25, for approximate cooking times.

NOTE

Tender cuts such as pork chops and pork tenderloin are braised without adding flour or pounding.

Brown on each side then cover pan and cook 20-30 minutes at low heat. One or two tablespoons of liquid may be added, if desired.

V. STEWING OR COOKING IN LIQUID

Cuts to stew or cook in liquid

Beef: neck, shank, corned beef, brisket, plate, short ribs, chuck, tongue, kidney, oxtails.

Veal: shank, tongue, heart.

Lamb: heart, tongue.

Pork: *Fresh:* hocks, spareribs, tongue.

Smoked: picnic shoulder, shoulder butt.

How to stew or cook in liquid

1. For stews, meat may be browned on all sides in melted fat. Small pieces cut in 1-1½ inch cubes may be floured before browning. Shake pieces in seasoned flour in a paper bag. This step is generally omitted for large cuts to be cooked in liquid.
2. Cover with liquid, using leftover vegetable stock, tomato or water.
3. Cover pan. Simmer (cook below boiling point) until tender. See Stewing and Liquid Cooking Chart (below) for approximate time.
4. When vegetables are to be cooked with meat, add vegetables just long enough before serving to be cooked.
5. Thicken broth, if desired, using 2 tbsp. flour, made into a paste with ¼ c. cold water, for each cup of gravy. Season to taste.
6. For stew with dumplings, see recipe for Dumplings, page 40.

STEWING AND LIQUID COOKING CHART

	WEIGHT	APPROXIMATE COOKING TIME
	LB.	HOURS
Beef		
Brisket or plate	3-4	3
Corned beef	3-4	3
Stewing beef, 1¾ inch pieces		2
Tongue	2-3	3½
	3-4	4
Oxtail	2	4
Lamb		
Heart	¼-½	1
Tongue	½	1
Veal		
Knuckle	1½-2	2
Heart	½	1½
Tongue	1½	1½
Pork		
Hocks	¾	3
Spareribs		2
Picnic shoulder, cured and smoked	6-8	3½
Boneless shoulder butt	2	1½
	4	2½
Tongue	¾	1½

Baked Meat Patties

- 1½ lb. ground meat
- ½ c. bread crumbs
- 2 tsp. salt
- ¼ tsp. pepper
- ½ tsp. dry mustard
- 1 onion, diced
- ½ c. vegetable stock, milk or tomato juice

1. Grease baking dish.
 2. Mix meat, crumbs, seasoning, onion.
 3. Add liquid.
 4. Shape lightly in patties.
 5. Bake in moderate oven, 350°, 45 minutes.
- Serves 6.

VARIATIONS

1. Wrap each patty in strip of bacon. Secure with toothpick.
2. Put layer of meat in pan, then layer of bread dressing, then layer of meat.
3. Use ½ c. quick-cooking rolled oats instead of bread crumbs.
4. Bake as meat loaf with row of hard-cooked eggs down centre.

Meat Loaf

- 1 lb. ground beef
 - ½ lb. ground pork
 - ½ lb. ground veal
 - 1 onion, diced
 - 3 tsp. salt
 - ½ tsp. pepper
 - ¼ c. bread crumbs
 - 1 c. tomato soup
- OR
- ¾ c. tomato juice
 - 2 eggs
 - 2 tbsp. parsley, chopped

1. Combine all ingredients.
 2. Mould into a loaf or press into a greased loaf pan, 9" x 5" x 3".
 3. Bake in moderate oven, 350°, about 1 hour or until done.
 4. Pour off excess dripping and save for other uses.
 5. To make gravy, use 2 tbsp. dripping and 2 tbsp. flour for every cup of meat stock, vegetable stock or water.
- Season gravy as desired.
- Serves 6-8.

Swiss Steak

- 1½ lb. steak, cut 1" thick, from shoulder, rump or round
 - seasoned flour
 - 2 tbsp. fat
 - 1 onion, sliced
 - 2 c. boiling water
- OR
- 1 c. water and 1 c. tomato juice

1. Roll meat in seasoned flour. Pound well on both sides with edge of plate or meat mallet.
 2. Brown meat on both sides in fat. Add onion and brown.
 3. Place meat and onion in greased casserole, 1½ qt. size. Add liquid and cover casserole.
 4. Simmer for 1 hour or bake in moderate oven, 350°, 1 hour, or until meat is tender.
- Serves 6.

NOTE

See illustration, page 24.

Beet and Vegetable Stew

- 2 onions, sliced
- 1/2 green pepper, diced (optional)
- 3 tbsp. fat
- 2 lb. stewing meat, 1" cubes
- seasoned flour
- 3 c. hot water
- OR
- 1 c. hot water and 2 c. tomato juice
- 4 carrots, quartered
- 4 potatoes, quartered
- 6 stalks celery, 1" lengths (optional)
- 1 c. peas
- 2 tsp. salt
- f.g. pepper
- 1 tsp. Worcestershire sauce

1. Brown onions and green pepper in fat.
 2. Roll meat in seasoned flour and brown in fat.
 3. Cover with hot water and tomato juice and simmer until meat is tender, 1 1/2 to 2 hours, or cook in pressure cooker, 10 minutes.
 4. Add raw vegetables and cook until tender, about 30 minutes or 5 minutes in pressure cooker.
 5. Add cooked vegetables. Season to taste.
 6. Thicken gravy with 2 tbsp. flour mixed with 1/4 c. cold water.
- Serves 8.

NOTE

Cooked stew may be placed in greased casserole and topped with tea biscuit mixture. See recipe for Tea Biscuit Topping below. Bake in hot oven, 425°-450°, about 20 minutes. See outside front cover.

Beef Upside-down Pie

- 1/2 c. onion, diced
- 4 tbsp. fat
- 1 lb. ground beef
- 4 tbsp. flour
- 2 c. tomato juice
- 1 tsp. salt

1. Cook onion in fat.
2. Add meat and flour. Stir until flour is blended.
3. Add tomato juice and salt and stir until thickened. Allow mixture to come to the boil.
4. Put mixture into greased casserole, 1 1/2 qt. size.

TEA BISCUIT TOPPING

- 1 c. sifted whole wheat flour
- 1 c. sifted pastry flour
- 4 tsp. baking powder
- 1/2 tsp. salt
- 1 tsp. paprika (optional)
- 1 tsp. celery salt (optional)
- 1/3 c. fat
- 2/3 c. 3/4 c. milk

1. Sift dry ingredients together.
 2. Cut in fat.
 3. Stir in milk and mix until dough leaves sides of bowl.
 4. Drop from spoon on meat mixture in casserole.
 5. Bake in hot oven, 425°-450°, about 20 minutes.
- Turn upside-down on serving platter or serve in baking dish.
- Serves 6.

Fish

Fish—let's use it more often! Fresh or dried, frozen or canned, fish is always on the market.

HERE'S HOW TO SELECT FISH

1. In *fresh* fish watch for these points: no strong odour, bright red gills, bright bulging eyes and firm elastic flesh.
2. Servings
For steaks or fillets allow $\frac{1}{3}$ lb. per serving
For dressed fish allow $\frac{1}{2}$ lb. per serving
For whole fish allow 1 lb. per serving

HERE'S HOW TO PREPARE FISH

1. Wash cleaned fish quickly under cold running water and wipe thoroughly with a wet, then a dry cloth.
2. Place fresh fish in the refrigerator or on ice and use promptly.
3. Frozen fish are most commonly eviscerated and cleaned before freezing.
 - (a) Frozen fish may be cooked in water or in fat without being thawed.
 - (b) Frozen fish to be baked, or stuffed and baked should be thawed. Thaw in wrapping in the refrigerator overnight or at room temperature for a shorter period. Fish may also be thawed in running cold water when speed is required.

Once fish is allowed to thaw cook immediately. Never refreeze fish.

HERE'S HOW TO COOK FISH

1. Use the right temperatures, 350°-375°, for baked stuffed fish; 450°-500°, for other baked or broiled fish.
2. Do not overcook. Fish is cooked when it flakes from the bones and is moist, tender and juicy.
 - (a) Baking or broiling: 10-15 minutes per inch thickness.
40-60 minutes for baked stuffed fish.
 - (b) Simmering: 8-10 minutes per lb. OR
10-15 minutes per lb. if fish is thick.
 - (c) Frozen fish will require a slightly longer time.
See "How to Prepare Fish" above.
3. Add richness and colour
 - (a) Fish has less fat than meat. Richness may be added in the form of sauces. White, tartare, tomato, egg and parsley sauces are traditional with fish. See recipes, page 34.
 - (b) Since many fish are lacking in colour, garnishes play an important part in serving. Try one of the sauces mentioned or merely sprinkle fish with paprika, melted butter, or chopped parsley; or serve lemon or cucumber slices with fish.

Baked Stuffed Fish

1. Scale the fish. Remove the head. Cut off tail. Cut around fins and remove them.
2. Slit fish open from head to tail along belly. Remove entrails. To remove backbone cut down to it, through flesh, on each side of fish. Break the backbone by bending the fish. Cut out backbone. Small bits of flesh adhering to backbone may be added to the stuffing.
3. Wash and dry the fish. Sprinkle inside and out with salt. Stuff fish loosely with dressing. Sew, tie or skewer cut edges together.
4. Place fish in greased pan. Brush with melted fat.
5. Bake in moderate oven, 350°, 40-60 minutes; *or* until fish flakes easily when tested with a fork. Baste with melted fat during baking, if fish is dry.
6. Serve on hot platter with garnishes, plain or with a sauce. See recipes, page 34.

BREAD STUFFING

- 1½ tbsp. onion, diced
- ¼ c. celery, diced (optional)
- 3 tbsp. melted fat
- ½ tsp. salt
- f.g. pepper
- ½ tsp. thyme, sage or savoury
- 2 c. bread crumbs

1. Brown onion and celery in fat.
2. Add other ingredients. Moisten dressing, if desired, with milk, water or other liquid.

Baked Fillets

1. Soak fillets for 3 minutes in ¼ c. milk, to which 1 tsp. salt has been added. Drain.
2. Place in a greased pan. Cover fillets with sifted bread crumbs. Sprinkle with melted fat.
3. Bake in very hot oven, 450°-500°, until cooked, about 10-15 minutes. Grated cheese may be sprinkled over top of fish just before removing from oven.

Broiled Fish

1. Clean the fish.
2. Sprinkle with salt and a few drops of lemon juice or vinegar (except for salmon). Place between the wires of a toast rack. If fish is very low in fat, sprinkle with melted fat.
3. Place in preheated broiler, 450°-500°, cooking the cut side first. Turn after about 6 minutes and cook other side. Ten to twelve minutes total cooking time is usually sufficient.

NOTE

If a toast rack is not available, place fish on a greased broiler rack. Turn fish *carefully*, when half cooked, to prevent breaking.

Fish Cooked in Milk

1. Cut fish in pieces for serving.
2. Soak in heavily salted cold water 5 minutes.
3. Place pieces of fish in boiling milk. Simmer until well cooked, 8-10 minutes per lb. or 10-15 minutes per lb. if pieces are very thick.
4. Prepare a sauce using the milk in which fish was cooked. Use 2 tbsp. butter and 2 tbsp. flour for each cup of liquid. See method for White Sauce, page 34.

Finnan Haddie in Milk

1. Cover fish with water and simmer a few minutes. Drain.
2. Place fish in pan and add 1 c. warm milk and 2 tbsp. butter.
3. Keep in a warm place until served but do not leave long enough for milk to curdle.

NOTE

Finnan Haddie is simmered in water first as the smoke in the fish would curdle the milk.

Fish Cooked in Water or Steamed Fish

1. Clean fish and rub salt over it.
2. Wrap fish in cheesecloth or parchment paper to keep fish from falling apart.
3. Place in container in which fish is to be cooked.
4. If cooking fish in water use hot, *not boiling*, water. Bring water to the boiling point and let simmer until done, 8-10 minutes per lb. if thin pieces, 10-15 minutes per lb. if thick pieces. Steaming takes longer.

Herbed Panfried Fish

1. Clean fish and cut into fillets.
2. Cut a pocket in each fillet 1½ inches long and deep. Stuff into this a teaspoon of fresh herbs; finely chopped dill and chives; tarragon, basil and summer savoury; parsley and chives or green onion tops; or any combination you prefer.
3. Dip each piece of fish in whole egg beaten with 1 tbsp. water.
4. Roll each piece in sifted cracker or bread crumbs.
5. Melt fat or butter in frying pan. Fry fish until brown and tender, about 3-5 minutes per side.

WORTH REMEMBERING

The most common faults in fish cookery are: to cook the fish too long; to use too low a temperature when baking; to use too high a temperature when cooking in liquid.

Sauces

White Sauce

- 1 c. scalded milk
- 2 tbsp. flour
- 2 tbsp. fat
- 1/2 tsp. salt
- f.g. pepper or paprika

1. Cream flour, fat and seasonings together in a bowl. Add to milk. Cook and stir until thick and smooth.
2. Cover and keep hot over hot water.

Egg Sauce

Add 1-2 chopped hard-cooked eggs to White Sauce (above).

Parsley Sauce

Add 2-4 tbsp. chopped parsley to White Sauce (above).

Tomato Sauce

Use 1 c. tomato juice in place of milk in White Sauce. If a spicy sauce is desired simmer 1 1/4 c. tomato juice, covered, with 1 slice onion, 2 cloves and 1 bay leaf for 5 minutes. Strain. If necessary make up tomato juice to 1 c. with water. Complete as for White Sauce.

Cucumber Sauce

- 1/2 c. cucumber, diced
- 2 tbsp. vinegar or lemon juice
- 1/2 c. whipped cream
- 1/4 tsp. salt
- f.g. pepper
- 1 tsp. pimiento, diced (optional)

1. Drain cucumber.
2. Beat vinegar slowly into cream. Add seasonings.
3. Fold in cucumber and pimiento.

Tartare Sauce

- 1 c. chilled mayonnaise
- 1/2 tsp. onion, diced
- 1/2 tsp. parsley, chopped
- 1 tbsp. cucumber pickles, chopped
- 1 tbsp. capers, chopped (optional)
- 1 tbsp. olives, chopped (optional)
- 1 tsp. vinegar

1. Combine ingredients just before serving.

Lemon and Parsley Sauce

- 1/4 c. butter, melted
- 1 1/2 tbsp. lemon juice
- 1 tbsp. parsley, chopped

1. Combine ingredients just before serving.

Poultry

Such happy times as Thanksgiving, Christmas and Easter dinners (and many other wonderful meals) centre around a royal bird. Poultry, as well as meat, needs to be tender, juicy and full of flavour when we serve it to our families and friends.

HERE'S HOW TO SELECT POULTRY

1. For wise selection of poultry buy by government grade. There are two classes of poultry.

Milkfed: white colour in fat deposits, soft texture in skin and flesh, evidence of special feeding. Milkfed poultry are graded: Special, Grade A, Grade B.

Selected: yellow colour in fat deposits, no evidence of milkfeeding. Selected poultry are graded: Special, Grade A, Grade B, Grade C.

2. Poultry should be plump in appearance with smooth, soft legs and feet and smooth, moist skin.
3. The eyes should be bright; the comb red. There should be an abundance of pin feathers.
4. The lower end of the breast bone should be flexible. The joint of the wing should twist easily when turned backward.
5. Avoid birds with a full crop.
6. Young birds are tender. Old birds, excepting capon, are tough.
7. Bruised, dry or purplish skin shows careless dressing or age. Hard, dry, scaly legs, hard breast bone and the presence of long hairs are signs of an old tough bird.

SELECT BY WEIGHT

	DRESSED WEIGHT		SERVINGS
Chickens			
Broilers -----	1	lb. - 1¾ lb.	½ chicken per person
Fryers -----	1¾	lb. - 2 lb.	¾ lb. per person
Roasters -----	3	lb. - 5 lb.	½ lb. - ¾ lb. per person
Fowl (stewing) -----	4	lb. - 6 lb.	¼ lb. - ½ lb. per person
Capons (roasting) -----	4	lb. and up	½ lb. - ¾ lb. per person
Turkeys			
Young hen turkeys -----	7	lb. - 15 lb.	¾ lb. - 1 lb. per person
Young toms -----	13	lb. - 20 lb.	¾ lb. - 1 lb. per person
Ducks			
	3½	lb. - 5 lb.	1 lb. per person
Geese			
	Weight range as for turkeys		1 lb. - 1½ lb. per person

LET'S COOK OUR POULTRY RIGHT
OVEN TEMPERATURE MAKES A DIFFERENCE



Poultry roasted in a SLOW oven has a smooth, glossy skin; is uniformly brown, with no shriveling, blistering or pulling away from bone.



Poultry roasted at TOO HOT a temperature has dry, blistered and cracked skin. It is too brown in colour and the meat has pulled away from the bone.

HERE'S HOW TO PREPARE POULTRY

- 1. Freshly killed poultry should be drawn immediately. Keep in a cool place and cook as soon as possible.
- 2. Frozen poultry should be eviscerated before freezing.
- 3. Wash poultry thoroughly both inside and outside. Do not allow to soak in water. Wipe both inside and outside with a clean cloth.

HERE'S HOW TO COOK POULTRY

I. Roasting Poultry

- 1. Stuff and truss poultry.
- 2. Place breast side up on rack in open pan.
- 3. Insert meat thermometer inside thigh next to the body. Internal temperature is the only true test for doneness.
- 4. Cover poultry with metal foil or with a cloth that has been dipped in melted fat.
- 5. Roast in slow oven, 325°, until tender. See Roasting Chart (below), for approximate cooking time.

NOTE ON FROZEN POULTRY

- 1. You may roast poultry from the frozen state or thaw it first.
- 2. If poultry is stuffed and ready for the oven you may put it right into the oven and start roasting it.
- 3. If poultry is not stuffed or is undrawn it must be thawed or partially thawed to prepare it for roasting. Use as soon as thawed sufficiently. A 3 lb. bird will thaw in 8 hours in the refrigerator or 4 hours at room temperature. Allow 48 hours for turkey to thaw in the refrigerator or 24 hours at room temperature. Leave in wrapping. Poultry may be thawed in running cold water if speed is required. Do not leave in water longer than necessary.
- 4. Roasting Chart (below), shows approximate times for thawed poultry (refrigerator temperature). Add about 15 minutes per lb. to times shown in Roasting Chart when poultry is roasted from frozen state.

POULTRY ROASTING CHART

OVEN TEMPERATURE: 325°

POULTRY	DRAWN WEIGHT LB.	APPROXIMATE COOKING TIME HOURS	INTERNAL TEMPERATURE
Chicken -----	3½	2½	190°
	4	3	190°
Turkey -----	8	3	190°
	10	3½	190°
	12	4	190°
	14	4½	190°
	18	5½	190°
Turkey over 18 lb. 300° -----	25	6½	190°
Duck same as chicken of similar weight			
Geese same as turkey of similar weight			

II. Broiled Chicken

1. Preheat broiler.
2. Split broilers down back and breast to separate halves.
3. Place on greased broiler rack skin side down and brush with melted fat.
4. Locate rack so that surface of chicken is 3-5 inches from source of heat.
5. Broil about 20 minutes. Season. Turn. Brush with additional fat. Broil other side about 20 minutes.
6. To test doneness, cut into thickest part of thigh. If juice is no longer pink and meat is tender, it is done.

NOTE

For frozen chicken allow an additional 20-30 minutes for each half; OR thaw and cook as fresh chicken.

III. Fried Chicken

fryers
seasoned flour
fat

1. Cut fryers into breast, thighs, wings, legs and back.
2. Dip in seasoned flour.
3. Heat frying pan and melt fat to a depth of $\frac{1}{2}$ inch.
4. Brown pieces of chicken slowly on all sides. Put in thick pieces first for longer cooking.
5. Turn heat low and continue frying 35-60 minutes depending on size of pieces. Or transfer chicken to covered casserole, $1\frac{1}{2}$ qt. size, and finish cooking in slow oven, 325° , 1 hour.

NOTE

1. Other coatings may be (a) mixture of cornmeal and flour; (b) thin batter.
2. For frozen chicken allow longer time; OR thaw and cook as fresh chicken.

IV. Braised Chicken

stewing fowl
seasoned flour
fat
paprika
salt
pepper
butter
 $1\frac{1}{2}$ c. hot water

1. Cut fowl in pieces for serving.
2. Roll each piece in seasoned flour, making sure it is well coated.
3. Brown in fat.
4. Place in casserole, $1\frac{1}{2}$ qt. size, and sprinkle with seasonings.
5. Dot each piece with butter.
6. Add water and cover closely.
7. Bake in slow oven, 325° , about 2 hours. Or cover and simmer slowly on top of stove, until chicken is tender.
8. Thicken gravy before serving, if desired.

NOTE

For frozen chicken allow a longer time; OR thaw and cook as fresh chicken.

V. Stewed Chicken or Fricassee of Chicken

The time is the same for either whole or cut up chicken.

- stewing fowl
- boiling water
- 2 tsp. salt
- 1 carrot
- 1 onion
- 1 sprig parsley
- 1 stalk celery (optional)
- 1 clove
- 2 whole peppercorns
- flour
- salt
- pepper

1. Place chicken in stewing kettle. Cover with boiling water. Add salt. Cover kettle closely and simmer 2½-3 hours or until tender.
2. Add vegetables and spices to increase flavour of chicken.
3. When chicken is tender remove from broth. Measure out broth to be used for gravy. Save remainder for soup. Thicken gravy with 2 tbsp. flour, made into paste with cold water, for every cup of broth. Season to taste. For chicken with dumplings, see recipe for Dumplings, page 40.

NOTE

For frozen chicken allow a longer time; or thaw and cook as fresh chicken.

WORTH REMEMBERING

Too high a cooking temperature will cause poultry to dry out and become toughened.

Giblet Gravy

- giblets and neck of fowl
- cold water
- ½ c. fat of fowl
- ⅓ c. flour
- salt
- pepper

1. Place giblets (liver, heart and gizzard) and neck in saucepan. Cover with cold water.
2. Simmer slowly until tender. Drain and save stock.
3. Remove flesh from neck and chop finely with giblets.
4. Leave about ½ c. fat in pan after roasting chicken or turkey. Stir in flour and blend.
5. Gradually add giblet broth to make a smooth gravy. Cook for 5 minutes stirring constantly.
6. Add chopped giblets and season to taste with salt and pepper.

Giblet Dressing

- giblets
- bread cubes
- onion, diced
- celery, diced
- fat
- parsley, chopped
- salt
- pepper
- poultry seasoning
- broth

4 LB. CHICKEN	12 LB. TURKEY
1 qt.	3 qt.
2 tbsp.	6 tbsp.
¼ c.	¾ c.
¼ c.	¾ c.
1 tsp.	1 tbsp.
1 tsp.	1 tbsp.
⅛ tsp.	¼ tsp.
¼ tsp.	¾ tsp.
½ c.	1½ c.

1. Simmer giblets until tender in salted water to cover.
2. Toast bread cubes lightly.
3. When giblets are tender, chop finely. Save broth, for dressing and gravy.
4. Cook onion and celery in fat until clear.
5. Combine all ingredients adding enough broth to moisten.

NOTE

Do not pack dressing into poultry. Dressing expands on cooking.

Dumplings

- 2 c. sifted flour
- 4 tsp. baking powder
- 1 tsp. salt
- 1 tbsp. fat
- about $\frac{3}{4}$ c. milk

1. Sift together dry ingredients.
2. Cut in fat.
3. Add milk, stirring quickly to make a soft dough.
4. Drop by small spoonfuls on top of simmering stew.
5. Cover and cook 12-15 minutes. Serve at once with hot stew.

Well-cooked poultry is

1. Juicy
2. Tender
3. Flavourful

Eggs

Do your meals ever become monotonous or humdrum? Your problems are whisked away when you fix up an omelet, souffle or dessert with high quality eggs.

HERE'S HOW TO SELECT EGGS

Eggs are graded as follows:

GRADE A. Best quality, available in three sizes; large, medium and pullet. Suitable for frying, soft-cooking, hard-cooking and poaching.

GRADE B. Good quality, suitable for cooking and baking.

GRADE C. Lowest graded quality eggs. May be used in highly seasoned dishes.

HERE'S HOW TO PREPARE EGGS

1. Wash all eggs before using.
2. Break eggs singly, into a separate dish, if several eggs are needed in one recipe. One poor egg will spoil others in the bowl.
3. Scrape all raw egg white out of shell. When this is not done there is considerable waste of egg white.

HERE'S HOW TO COOK EGGS

Use *low* temperature. Only gentle heat will produce a tender egg product.

- (a) If eggs are cooked in water, cook under boiling point.
- (b) egg dishes baked in the oven require a slow oven, 250°-350°. At 325° or over it is best to oven-poach such egg products as baked custards.

TO OVEN-POACH. Set the casserole or pan, in which egg product is to be cooked, inside another pan and surround casserole with hot water.

OVEN TEMPERATURES FOR SOME EGG PRODUCTS

Angel cake	275°-300°
Custards	325°-350°. See recipes, page 57-58.
Custard pie	See recipe, page 86.
Meringue (cooked separately)	250°-300°
Meringue (on pie or pudding)	325°-350°. See recipe, page 84.
Souffles	325°
Sponge cake	300°-325°

Soft-Cooked Eggs

- (a) Put eggs in boiling water to cover. Set saucepan in a warm place, off the heat, 5-8 minutes for a medium soft-cooked egg.

OR

- (b) Cover eggs with cold water and bring to a boil. Remove at once for soft-cooked or coddled egg. Or remove pan from heat and leave eggs in water 2-5 more minutes for medium soft-cooked egg.

Hard-Cooked Eggs

- (a) Follow the method for soft-cooked eggs but allow saucepan to stand in warm place 20-30 minutes.

OR

- (b) Put eggs in cold water. Heat water to boiling point, then set pan off heat in a warm place, 20 minutes.

NOTE

Cool hard-cooked eggs as soon as cooking time is complete. Prompt cooling of hard-cooked eggs will:

1. Prevent overcooking.
2. Help prevent the dark ring which sometimes appears around the yolk of hard-cooked eggs.
3. Make the shell come off more easily. Start peeling at the large end of the egg.

Devilled Eggs

1. Cut cooled hard-cooked eggs (above) in half, lengthwise or crosswise.
2. Remove yolks and press through a sieve or mash with a fork.
3. Add salt, pepper, salad dressing to moisten, other seasonings to taste.
4. Refill whites with mixture and garnish with paprika, parsley or other greens.



A well-drained, attractively served poached egg. Poached eggs are tender when cooked below the boiling point in salted water.

Poached Eggs

1. Fill shallow pan or frying pan three-quarters full of boiling salted water. Bring water back to boil.
2. Break egg into a saucer, then slip it gently into water. Repeat with other eggs.
3. Remove pan from heat, cover and keep hot until eggs are set to the stage desired.
4. Lift eggs out of water with egg lifter. Drain on cloth or absorbent paper before sliding egg onto toast or serving plate.

Fried Eggs

1. Melt fat in frying pan.
2. Reduce heat to cook eggs slowly and cover pan if desired.
3. Cook until firm, basting with melted fat, if desired, to cook yolk.
4. Drain off most of fat before serving.

Scrambled Eggs

1. In frying pan, melt 1 tsp. fat for each egg.
2. Beat eggs until whites and yolks are well mixed.
3. Season with salt and pepper and add 1 to 3 tbsp. liquid for each egg.
4. Pour egg mixture into hot fat and cook slowly. Stir constantly until eggs are the desired consistency. Serve at once.

NOTE

Scrambled eggs may also be prepared in the double boiler using the same recipe and method.

French Toast

- 3 eggs
- $\frac{1}{2}$ tsp. salt
- 2 c. milk
- 12 slices bread, cut $\frac{1}{2}$ " thick
- fat

NOTE

Stale bread may be used in this recipe.

OMELETS

Puffy Omelet

- fat
- 5 eggs
- 5 tbsp. milk, cream or water
- $\frac{1}{2}$ tsp. salt
- f.g. pepper

1. Beat eggs.
 2. Add salt and milk.
 3. Dip bread into egg mixture.
 4. Fry bread in fat until a delicate brown on both sides.
 5. Serve hot with currant or grape jelly, maple syrup or bacon.
- Serves 6.

1. Set oven for 350° .
 2. Melt fat in frying pan, turning pan to grease bottom and sides thoroughly.
 3. Separate eggs.
 4. Beat yolks until thick and lemon coloured. Add liquid and seasonings.
 5. Beat egg whites until they stand up in peaks.
 6. Cut and fold yolks into whites. Do not beat. When blended pour into greased pan and cook slowly until bottom is brown, about 10 minutes.
 7. Place in moderate oven, 350° , about 15 minutes, to cook top of omelet.
 8. Fold omelet by creasing lightly and serve at once on hot platter. Garnish with parsley.
- Serves 4.

French Omelet

Ingredients as in Puffy Omelet above.

1. Melt fat in frying pan.
 2. Beat eggs enough to mix whites and yolks.
 3. Add liquid and seasonings.
 4. Turn egg mixture into frying pan. As omelet cooks prick the bottom and sides to let liquid portion on top run underneath, until all egg is cooked.
 5. When bottom of omelet is lightly browned, fold and turn out on hot platter. Garnish with parsley. Serve at once.
- Serves 4.

WORTH REMEMBERING

For eggs done to perfection use gentle low heat.



For dessert why not try cheese and crackers with fruit? This is a summer or winter treat served with tea or coffee, either iced or hot.

Cheese

Few foods appear in as many varieties as cheese. Why not serve cheese often and make use of the different kinds? Cheese is very good food and may take the place of milk, meat, fish or eggs in a hearty meal.

HERE'S HOW TO SELECT CHEESE

1. *Hard cheese* is best for slicing or grating; $\frac{1}{2}$ lb. hard cheese makes approximately 2 c. grated cheese.
 - (a) The most common hard cheese is known as Canadian, cheddar or standard factory cheese. There are many other varieties of hard cheese.
 - (b) Buy cheddar cheese by the pound. Cheddar cheese is more economical pound for pound than most types of cheese.
 - (c) Cheddar cheese is mild, medium or strong in flavour depending on whether it is new or old.
 - (d) New cheddar cheeses are waxy in texture; older ones are crumbly.

- (e) Cheddar cheese is made into *process cheese* which is packaged by several well-known companies. Process cheese is suitable for slicing and grating but may be used for spreading also. It is soft, smooth and always of the same texture.
- 2. *Soft cheese* is best for spreading.
 - (a) There are many varieties of soft cheese; cottage cheese and cheeses ripened by bacteria and moulds.
 - (b) Soft cheese has less food value per pound than hard cheese owing to the higher moisture content.
 - (c) Most soft cheese is bought in package form or in special containers and is generally more expensive than cheddar cheese.

HERE'S HOW TO STORE CHEESE

1. Keep cheese in covered container or wrapped in wax or parchment paper.
2. Store cheese in a cool place.

HERE'S HOW TO COOK CHEESE

1. Cook cheese at a *low* temperature. High temperatures toughen cheese.
2. Cook cheese over hot water, never over direct heat.
3. When making cheese sauce, add cheese at the last and cook only until melted.
4. Any mixture of cheese, eggs and milk to be cooked in the oven should be oven-poached in a slow oven, 325°-350°.

TO OVEN-POACH. Set the casserole or pan, in which product is to be cooked, in another pan and surround casserole with hot water. Product is done when a knife, put into the centre, comes out clean.

Well-cooked cheese is

1. Melted
2. Tender

Cheese Fondue

- 2 c. brown bread cut in $\frac{2}{3}$ " cubes
- 1 c. cheese, grated
- 2 eggs
- 2 c. milk
- 2 tbsp. fat, melted
- 1 tsp. salt
- f.g. pepper

1. Grease casserole, 1½ qt. size.
 2. In it place cubes of bread and cheese in layers, ending with bread on top.
 3. Beat eggs, add milk, fat and seasonings.
 4. Pour mixture over bread. Allow to stand 20 minutes.
 5. Place casserole in a pan of hot water and bake in moderate oven, 350°, 35-40 minutes.
- Serves 4-5.

WORTH REMEMBERING

Too high a temperature or too long cooking will cause cheese to become tough, stringy or lumpy.

Welsh Rarebit

- 1 c. scalded milk
- 2 tbsp. flour
- 2 tbsp. fat
- 1/4 tsp. salt
- f.g. pepper
- f.g. paprika
- 2 c. cheese, grated
- 1 egg, slightly beaten

Cheese Souffle

- 1 c. cheese, grated
- 4 tbsp. flour
- 3 tbsp. fat
- 1/4 tsp. salt
- f.g. pepper
- 3 egg yolks, beaten
- 1 c. cheese, grated
- 3 egg whites, beaten stiff but not dry

NOTE

If desired, 1/8 tsp. cream of tartar may be added to the partially beaten egg whites. This helps prevent the souffle from falling so rapidly after removal from the oven.

Cottage Cheese

Instead of disposing of the sour milk why not make some cottage cheese?

- 1 qt. sour milk
- salt

1. Cream flour, fat and seasonings together in a bowl. Add to milk in double boiler. Cook and stir until thick and smooth.
2. Blend in cheese until melted.
3. Combine egg with sauce, first adding a little of the sauce to egg. Return mixture to sauce in double boiler.
4. Cook two minutes. Serve at once on toast or crackers. Serves 4-5.

1. Cream flour, fat and seasonings together in a bowl. Add to milk in double boiler. Cook and stir until thick and smooth.
2. Fold egg yolks into white sauce, first adding a little of the sauce to the egg yolk and stirring thoroughly.
3. Add grated cheese. Remove from heat. Cool slightly.
4. Fold sauce into beaten egg whites. Pour into casserole, 1 1/2 qt. size. Set casserole in pan of hot water (oven-poach).
5. Bake in slow oven, 325°, 1-1 1/4 hours until knife put into centre comes out clean. Serve at once. Serves 4-5.

Cottage Cheese Salad

- 1 c. cottage cheese
- 1/4 c. mayonnaise
- 1/2 tsp. salt
- f.g. pepper
- 2 green onions, chopped
- 1 tsp. parsley, chopped

1. Place sour milk in double boiler over hot water.
2. Allow to stand until curds and whey separate and become lukewarm. Curd will become tough if allowed to get hotter.
3. Remove from heat. Strain through two thicknesses of cheesecloth. Allow to hang until liquid has drained off curd.
4. Season with salt. Add cream to moisten.

1. Combine. Serve on lettuce.



Here's a favourite. Macaroni and cheese with a creamy, cheese-rich, white sauce, served with a crisp tossed salad.

Macaroni and Cheese

- 2 c. scalded milk
- 1 tbsp. onion, diced
- 1 c. macaroni, uncooked
- 4 tbsp. flour
- 2 tbsp. fat
- $\frac{1}{4}$ tsp. dry mustard
- $\frac{1}{2}$ tsp. salt
- 1 c. cheese, grated
- 2 tbsp. wheat germ

TOPPING

- 2 tbsp. bread crumbs
- 2 tbsp. cheese, grated

1. Add onion to milk and scald in double boiler.
 2. Cook macaroni in boiling salted water until tender. Drain. Rinse in cold water.
 3. Cream flour, fat and seasonings together in a bowl. Add to milk. Cook and stir until thick and smooth.
 4. Add grated cheese and wheat germ. Remove from heat.
 5. Mix sauce and macaroni. Place in greased casserole, $1\frac{1}{2}$ qt. size. Cover with topping.
 6. Bake in moderate oven, 350° , 15-20 minutes until topping is browned.
- Serves 6.

Cheese and Cabbage Salad

- 2 c. cabbage, shredded
- 2 tbsp. pickle, chopped
- $\frac{1}{3}$ c. old cheese, grated
- $\frac{1}{2}$ c. French dressing,
recipe page 13

1. Toss together lightly just before serving.

Soup

*Beautiful Soup, so rich and green,
Waiting in a hot tureen!
Who for such dainties would not stoop?
Soup of the evening, beautiful Soup!
Soup of the evening, beautiful Soup!
 Beau --- ootiful Soo --- p!
 Beau --- ootiful Soo --- p!
Soo -- oop of the e - e - evening,
Beautiful, beautiful Soup!*

"Alice in Wonderland".

There are two main types of soup, those made with meat stock and those made with a white sauce.

WORTH REMEMBERING

Vegetable stock is the water in which vegetables have been cooked. It should be saved and used in soups and gravies, because it contains valuable minerals and vitamins.

Save celery tops and leaves, tomato cuttings, or any leftover vegetables and add to stock.

Meat Stock

- | | |
|---|---|
| 2 lb. beef, $\frac{1}{4}$ to $\frac{1}{2}$ bone | 1. Cut meat in 1" cubes and brown in fat. |
| 2 tbsp. fat | 2. Soak meat and bone in cold water or vegetable stock for 30 minutes to 1 hour before cooking. This helps to extract the juices. |
| 2 qt. cold water or cold vegetable stock | 3. Heat gradually to simmering point. Continue to simmer 3 hours. Do not boil as it will not have as fine a flavour. |
| $\frac{1}{2}$ c. onion, sliced | 4. Add remaining ingredients and continue simmering from $\frac{1}{2}$ to 1 hour. |
| $\frac{1}{4}$ c. carrot, diced | 5. Strain through moistened cheesecloth. |
| 1 bay leaf | |
| 1 tbsp. salt | |
| $\frac{1}{4}$ c. celery with leaves | |
| spring parsley | |

HERE'S HOW TO CLARIFY MEAT STOCK

Allow 1 egg white and 1 shell to 1 quart of stock. Crush the shell and mix with the slightly beaten egg white. Add to stock and heat gradually to the boiling point, stirring constantly. Then boil 2 to 5 minutes without stirring. Remove from heat. Add $\frac{1}{4}$ cup cold water for each quart of stock and allow to settle. Strain through 2 thicknesses of cheesecloth.

The coagulated egg white collects the small particles of solid substances in the stock which would pass through the cheesecloth.

HERE'S HOW TO STORE MEAT STOCK

Cool the stock quickly because quick cooling improves the keeping quality of the soup. Soup should, if possible, always be allowed to become thoroughly cold before being used. The fat hardens, collects in a cake on top and can be removed

easily. Do not remove fat from the top of meat stock until stock is to be used. Loosen fat around the edges with the thin blade of a knife. Remove the cake of fat and any small remaining bits of fat.

Keep stock in a cold place, as it spoils quickly if it is not kept chilled. Spoiled stock, like spoiled meat, is dangerous food.

STOCK SOUPS

A good stock soup is

1. Piping hot
2. Pleasing to the eye
3. Perfect in rich meaty flavour

Vegetable Soup

- 1 qt. meat stock
- 1/4 c. green peas, cooked
- 1/4 c. green or wax beans, cooked
- 1/4 c. cooked carrots, cut in cubes or strips
- 1/4 c. cooked turnips, cut in cubes or strips

1. Heat soup stock.
 2. Add vegetables.
 3. Reheat and serve.
- Serves 6.

Old Fashioned Vegetable Soup

- 2 lb. brisket
- 1/2 c. pearl barley
- 1 c. dried navy beans
- 2 qt. water
- 1/2 c. onion, sliced
- 1/2 c. turnip, diced
- 1 1/2 c. cabbage, shredded
- 1 c. canned or fresh tomatoes
- 1 c. celery, diced
- 2 tsp. salt
- f.g. pepper

1. Put brisket, barley and beans in cold water and bring slowly to simmering point. Skim if necessary.
 2. Simmer 2 hours.
 3. Add vegetables and simmer 1/2 hour.
 4. Season.
- Serves 8-12.

Mother's Special Soup

- 1 lb. beef chuck, cut in 1" cubes
- 3 tbsp. fat
- 2 onions, sliced
- 1 tsp. pepper
- 2 tbsp. salt
- 1 lb. marrow bone, cracked
- 1-28 oz. tin or 3 1/4 c. cooked tomatoes
- 6 c. cold water
- 1 quartered apple, cored, pared
- 1/4 c. lemon juice
- 2 tbsp. brown sugar
- 6 c. cabbage, shredded
- 4-6 quartered potatoes

1. Brown meat in fat.
2. Add onions and brown lightly.
3. Add pepper, salt, bone, tomatoes, cold water and apple.
4. Cover, bring to boil and simmer 2 hours.
5. When meat is tender, add lemon juice, brown sugar, cabbage and potatoes. Cook covered 30 minutes.



Any cream of vegetable soup (be it cabbage, potato, tomato, celery or any favourite) is easy to make from one good basic recipe.

Cream Soup

- 2 c. scalded milk
- 2 c. sieved vegetable and juice
- 2 tbsp. flour
- 4 tbsp. butter
- 1 tsp. salt
- additional seasonings, as desired

NOTE

1. *Some vegetables thicken more than others. When vegetables such as potatoes and squash are used, reduce the flour one-half.*
2. *Soak dried vegetables overnight before cooking.*
3. *In making Cream of Tomato Soup, use 2 c. tomato juice or sieved tomatoes in place of 2 c. sieved vegetable stock. Heat tomato just before adding to hot white sauce. Stir the tomato slowly in the white sauce.*

1. Any fresh, canned or dried vegetable may be used.
2. To prepare 2 c. sieved vegetable and juice use:
 - (a) 2 c. raw vegetable, cut in small pieces, or if leafy, packed down.
 - (b) $1\frac{1}{2}$ c. vegetables which pack closely, as peas, corn and parsnips.
 - (c) $\frac{1}{2}$ c. dried vegetables.
3. Cook vegetable in boiling water until tender and press through a strainer or puree sieve. There should be 2 c. sieved vegetable and stock. If there is too much stock, drain before sieving. If too little, add water to make 2 c.
4. Cream flour, butter and salt together in a bowl. Add to milk in double boiler. Cook and stir until smooth.
5. Add sieved vegetables and stock. Keep hot over boiling water. Serves 5.



Vegetable Chowder. Serve it piping hot for supper! See recipe, page 52.

CHOWDERS

Chowders usually have milk for a base and may have vegetables, meat or fish served in the liquid.

Carrot Potato Chowder

- | | |
|----------------------------|--|
| 2 c. scalded milk | 1. Brown onion in 1 tbsp. fat. |
| 1 onion, sliced | 2. Add potatoes, carrots, boiling water, salt and paprika. |
| 3 tbsp. fat | 3. Boil 15 minutes, covered or until potatoes and carrots are tender. |
| 2 c. potatoes, diced | 4. Cream flour and remaining 2 tbsp. fat together in bowl. Add to milk in double boiler. Cook and stir until smooth. |
| 1 c. carrots, diced | 5. Combine sauce with vegetable mixture. |
| 2 c. boiling water | Serves 4-6. |
| 1 tsp. salt | |
| $\frac{1}{4}$ tsp. paprika | |
| 2 tbsp. flour | |

A good cream soup or chowder is

1. Piping hot
2. Pleasing to the eye
3. Perfect in smooth, smooth flavour
4. Neither too thick nor too thin (just like rich table cream)

Vegetable Chowder

- $\frac{1}{4}$ c. barley
- $\frac{3}{4}$ c. boiling water
- $\frac{3}{4}$ tbsp. onion, diced
- $\frac{1}{3}$ c. fat
- $\frac{1}{3}$ c. celery, chopped
- OR
- $\frac{1}{2}$ tsp. celery salt
- 1 c. carrots, diced
- 1 c. potatoes, diced
- $\frac{1}{3}$ c. turnips, diced
- $\frac{3}{4}$ tsp. salt
- $\frac{1}{4}$ tsp. pepper
- $\frac{3}{4}$ tbsp. parsley, finely chopped
- $\frac{3}{4}$ c. milk

1. Stir barley into boiling water and cook for 40 minutes.
 2. Brown onion lightly in hot fat. Add to barley.
 3. Add celery, carrots, potatoes, turnips and seasonings. Cook 30 minutes.
 4. Add parsley and cook 10 minutes.
 5. Add milk. Heat and serve.
- Serves 6.

NOTE

See illustration, page 51.

Fruit

The smart cook makes frequent use of fruits. She knows she can serve them at any meal, breakfast, dinner or supper. Fruits are the simplest and easiest of all desserts to prepare. They are good to eat and good for the family.

HERE'S HOW TO STORE FRUIT

1. Keep fruit in a cool place. There is an exception to every rule: keep bananas in a warm place.
2. All fruit, except raspberries, should be washed before serving. Raspberries merely require careful picking over.

HERE'S HOW TO PREPARE HALF GRAPEFRUIT AND ORANGE

1. Cut in half, across the fruit.
2. Insert a sharp knife between flesh and membranes of each section.
3. Run knife around, inside of the white part, loosening the flesh. Take care that no white rind clings to flesh.
4. If desired, cut out centre with sharp knife or scissors. Serve chilled.

HERE'S HOW TO SECTION GRAPEFRUIT AND ORANGE

1. Cut off slice at each end of fruit, through to the flesh.
2. Place fruit on cut end. With sharp knife slice off skin all the way around fruit, from top to bottom. Trim off any white rind that remains. Turn fruit over on other end and complete the trimming.
3. Insert knife at each section between membrane and flesh. Cut sections from membrane.

HERE'S HOW TO PREPARE FRUIT JUICE

1. Squeeze chilled fruit, remove seeds but do not strain.
2. Serve.
3. Fruit juice may be prepared in advance, put in a tightly covered container and stored overnight in a cold place, with little loss of vitamins. However, the flavour of orange juice is not quite up to the standard of freshly prepared juice. Frozen concentrated orange juice and canned citrus fruit juices are good foods.

HERE'S HOW TO PREPARE BERRIES

1. Spread berries on flat surface and remove soft or mouldy fruit.
2. Place in colander. Wash by dipping in cold water. Drain.
3. Stem or hull.
4. If desired, sprinkle with berry or fruit sugar. Lemon juice may be added to bland fruit for flavour and tartness.

HERE'S HOW TO PREPARE STEWED DRIED FRUIT

If the dried fruit has a tough skin, it is generally soaked overnight to plump before cooking. Use 3 to 4 cups water to each cup of fruit. If soaked in hot water, 2 to 3 hours only are required for plumping. If the dried fruit has a thin skin and soft flesh it need not be soaked.

Stewed Dried Fruit

- 1 lb. dried fruit
water
 $\frac{1}{2}$ lemon, sliced
OR
1 orange slice

1. Wash fruit well. Soak overnight in cold water, or soak 1-2 hours in hot water.
 2. Add lemon or orange.
 3. Cook in soaking water over hot water until tender.
 4. If desired, sugar to taste may be added. Usually this is not necessary for dried fruits.
- Serves 8.

Applesauce I

- 8 tart apples
 $\frac{2}{3}$ c. water
 $\frac{1}{2}$ c. sugar
1 tbsp. lemon juice
OR
 $\frac{1}{4}$ tsp. cinnamon
OR
 $\frac{1}{4}$ tsp. nutmeg

1. Wash, quarter, core and pare apples.
 2. Add water. Cook until apples are soft.
 3. Add sugar. Stir until dissolved.
 4. Add flavouring.
- Serves 6.

Applesauce II

recipe of Applesauce I (above)

1. Proceed as above but do not pare apples.
 2. When apples are cooked, press through sieve.
 3. Add sugar. Stir until dissolved.
 4. Add flavouring.
- Serves 6.

Stewed Rhubarb

- 4 c. rhubarb, cut in 1" pieces
- 1 c. sugar
- 3 tbsp. water
- 1 tbsp. orange rind, grated

1. Place rhubarb in saucepan with sugar, water and orange rind.
 2. Bring to boiling point and cook slowly, stirring once or twice with a fork, until tender.
 3. Rhubarb may be baked in moderate oven, 350°, or cooked over boiling water until tender.
- Serves 6.

Fruit Whip

- 2 egg whites
- $\frac{1}{4}$ c. sugar
- $1\frac{1}{2}$ c. well-drained fruit, sieved or chopped

1. Beat egg whites until stiff but not dry.
 2. Add sugar gradually. Continue beating.
 3. Add fruit and beat until well mixed. May be served with custard sauce or whipped cream.
- Serves 4.

Fruit Crumble

- 3 c. tart fruit, diced
- 1 tbsp. flour
- $\frac{1}{2}$ c. sugar
- 1 tsp. cinnamon
- $\frac{1}{8}$ tsp. salt
- 1 tbsp. water

TOPPING

- 6 tbsp. flour
- 6 tbsp. butter
- $\frac{1}{2}$ c. brown sugar
- $\frac{1}{2}$ c. quick-cooking rolled oats

1. In greased casserole, $1\frac{1}{2}$ qt. size, combine first 6 ingredients.
 2. Cream flour, butter and brown sugar.
 3. Stir in rolled oats. Sprinkle over fruit.
 4. Bake in moderate oven, 350°, 40 minutes or until fruit is tender and top is brown.
- Serves 5-6.

NOTE

If fruit is sweet, vary the sugar accordingly.

Fruit Cup

- 1 grapefruit, sectioned
- 2 oranges, sectioned
- 1 banana, sliced
- 1 apple, diced
- $\frac{1}{2}$ c. fruit juice

1. Combine all ingredients.
- Serves 4.

NOTE

Be certain that the banana and apple are covered with fruit juice so that they will not discolour.

Use any appetizing combination of fresh or canned fruits. A good way of using "odds 'n' ends" or leftovers.

Desserts

FRUITS

Juicy June strawberries. Red raspberries, big as thimbles. Ice-cold cantaloupe. Sliced peaches with rich cream. These fresh fruits in season are foods for the gods! They are quickly prepared and they are "good for you". Serve fresh fruits frequently in season. Freeze and can a supply to serve in the winter months.

When the snow flies and the fresh fruits of summer and autumn are only pleasant memories, make abundant use of oranges and grapefruit. For variety, make fruit cups combining oranges and grapefruit. A few slices of banana will be a welcome addition to the citrus fruits. Diced preserved fruits mixed with raw apples, oranges and grapefruit make a delicious winter dessert.

When we think of desserts, let's think first of fruits. See the fruit section of this book which begins on page 52.

CUSTARDS

Smooth, smooth custard without a suggestion of a curdle or lump! That's the kind of custard we all like. Such custards are easy to make if we remember just two things.

1. Custards curdle when we use too strong heat

Custard sauce or soft custard should be cooked, stirring constantly, over a small amount of gently boiling water. Cooking such custards over direct heat is almost certain to cause curdling.

Baked custard should be cooked in a slow oven, 325°-350°. Place baking dish in a pan and surround with hot water. This method of cooking is called "oven-poaching".

2. Custards curdle when we cook them too long

Even with low heat, a custard will curdle if it is cooked too long.

Cook and stir soft custard only until the mixture coats a metal spoon. Remove from the stove and cool quickly.

Cook a baked custard only until a knife, inserted carefully in the middle of the custard, comes out clean. Cool quickly.

Soft Custard or Custard Sauce

- 2 c. scalded milk
- 4 tbsp. sugar
- $\frac{1}{4}$ tsp. salt
- 2 eggs or 4 yolks
- $\frac{1}{2}$ tsp. vanilla

1. To scalded milk, add sugar and salt.
2. Add milk mixture to slightly beaten eggs.
3. Cook, over gently boiling water, stirring constantly until custard coats a metal spoon.
4. Remove from heat, strain and cool quickly.
5. Add vanilla.
6. Use for Fruit Custard (below), or Trifle. See recipe, page 57. Serve as sauce on desserts. See Gelatine Desserts, page 60.

NOTE

If custard curdles, beat with Dover egg beater. This will restore the smoothness but the custard will be thinner. Cooking over boiling water, only until mixture coats a metal spoon, continuous stirring and rapid cooling will *prevent* curdling.

A good soft custard or custard sauce is

1. Smooth
2. Thick as rich cream
3. Delicately flavoured
4. Cold

Fruit Custard

- recipe of Soft Custard (above)
- 4 oranges

1. Section orange. See page 52.
2. Place orange sections in serving dish.
3. Pour cold custard over oranges.
4. Serve with whipped cream or Meringue made from 1 egg white. See recipe, page 84.
Serves 5-6.

NOTE

Other fresh fruits or drained canned fruits may be used in place of oranges.

Trifle

recipe of Soft Custard, page 56.

2 c. stale cake

$\frac{1}{3}$ c. fruit juice

fruit (such as 6-8 halves of peaches)

1. Cut cake in uniform pieces. Arrange in serving dish.
2. Sprinkle with fruit juice. Add fresh or cooked fruit cut in pieces.
3. Pour cold custard over cake and fruit. Chill.
4. Garnish with whipped cream or meringue, cherries or red jelly. Serves 6.

NOTE

Raspberry jam may be used in addition to fruit in this recipe.

Baked Custard

2 c. scalded milk

3 tbsp. sugar or 4 tbsp. honey

$\frac{1}{4}$ tsp. salt

2 eggs or 4 yolks (if baked in individual servings)

OR

3 eggs or 6 yolks (if baked in one large dish)

$\frac{1}{4}$ tsp. vanilla

f.g. nutmeg (optional)

1. To scalded milk add sugar or honey and salt.
2. Add milk mixture to slightly beaten eggs, vanilla and nutmeg.
3. Strain into baking dishes. Place baking dishes in pan and surround with hot water.
4. Bake in slow oven, 325° - 350° , until knife inserted carefully in middle of custard, comes out clean. Approximate baking times: individual servings, 30 minutes; one large dish, 60 minutes.
5. Cool quickly. Serve cold. Serves 5.

NOTE

Most people prefer custard baked in individual servings.

A good baked custard is

1. Firm, with no suggestion of "watering" or "weeping"
2. Delicately flavoured
3. Cold
4. Attractively served

Chocolate Custard

Use recipe of Baked Custard (above).

Melt $\frac{1}{2}$ oz. chocolate in scalded milk. Beat with Dover egg beater before combining with other ingredients.

Caramel Custard

Use recipe of Baked Custard (above).

Omit sugar. Add $\frac{1}{4}$ c. Caramel Syrup. See recipe, page 59.

Bread Pudding

Bread puddings are custard mixtures which are partially thickened by bread.

- 2 c. scalded milk
- 1 c. fresh bread crumbs, tightly packed

OR

- $\frac{2}{3}$ c. very dry bread crumbs
- 2 tbsp. butter
- 3 tbsp. sugar
- $\frac{1}{4}$ tsp. salt
- 1 egg or 2 yolks, slightly beaten
- $\frac{1}{2}$ tsp. vanilla

1. Add bread crumbs and butter to scalded milk. Let stand until crumbs are soft.

2. Mix and cook as Baked Custard, page 57, using greased baking dishes.

Approximate baking times: individual servings, 25 minutes; one large dish, 50 minutes.

Serves 5.

Chocolate Bread Pudding

Use recipe of Baked Custard (above).

Melt 1 oz. chocolate in scalded milk. Beat with Dover egg beater before adding bread crumbs. Omit butter.

BLANC MANGE AND VARIATIONS

"Blanc mange" is the name which is usually given to a plain milk pudding thickened with flour or cornstarch. Blanc mange is an inexpensive pudding and can be very delicious if we "cook it right". Many milk puddings are variations of blanc mange.

A good blanc mange (or variation) is

1. Smooth as velvet
2. Thick enough to hold its shape but not "rubbery"
3. Light and fluffy
4. Flavourful

Here are some of the common faults of blanc mange and ways of avoiding them.

Common Fault

How to Avoid

LUMPS

1. Mix flour or cornstarch and sugar thoroughly.
2. Add part of milk cold to dry ingredients.
3. Cook over boiling water.
4. Stir continuously as pudding thickens.

TOO THICK OR TOO THIN

1. Follow a tested recipe.
2. Use standard measuring spoons and cup.
3. Use level measurements.
4. Cook required length of time.

POOR FLAVOUR

1. Cook for required length of time to avoid the taste of raw starch.
2. Add flavouring after pudding is removed from stove and cooled slightly. Such flavourings as vanilla, almond and lemon extracts evaporate when added to hot food.
3. For extra flavour, plain blanc mange may be served with fresh, frozen or canned fruit.

WORTH REMEMBERING

Blanc mange and variations are improved by beating with Dover egg beater after cooling slightly. This beating makes the pudding light and fluffy.

Creamy Blanc Mange

- 1 $\frac{3}{4}$ c. scalded milk
- 4 tbsp. flour
- 4 tbsp. sugar
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{4}$ c. cold milk
- 1 egg or 2 yolks, beaten
- 1 tsp. vanilla

Lemon Pudding

Use recipe of Creamy Blanc Mange (above). Add finely grated rind of 1 lemon to milk. Use $\frac{1}{2}$ tsp. almond flavouring. Omit vanilla.

Caramel Pudding (a variation of Blanc Mange)

- 1 $\frac{1}{2}$ c. scalded milk
- 4 tbsp. flour
- 3 tbsp. sugar
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{4}$ c. cold milk
- 1 egg or 2 yolks, beaten
- 1 tbsp. butter
- 5 tbsp. Caramel Syrup (below)

Caramel Syrup (for flavouring)

- 1 c. sugar
- 1 c. water, boiling rapidly

1. Mix flour, sugar and salt. Gradually add cold milk.
2. Add scalded milk. Cook over boiling water. Stir as mixture thickens.
3. Continue cooking, stirring occasionally for 10 minutes.
4. Combine some of hot mixture with egg. Stir into pudding. Cook 5 minutes longer.
5. Cool in pot until pudding thickens slightly. Beat with Dover egg beater. Add vanilla. Pour into serving dishes. Chill. Serve plain or with fresh, frozen or canned fruit.
Serves 4-5.

1. Mix flour, sugar and salt. Gradually add cold milk.
2. Add scalded milk. Cook over boiling water. Stir as mixture thickens.
3. Continue cooking, stirring occasionally for 10 minutes.
4. Combine some of hot mixture with egg. Stir into pudding. Add butter and syrup. Cook 5 minutes longer.
5. Cool in pot until pudding thickens slightly. Beat with Dover egg beater. Pour into serving dishes. Chill.
Serves 4-5.

1. Melt sugar in small or medium sized frying pan. Brown lightly. Shake pan to heat sugar evenly. Do not stir unless absolutely necessary.
2. Add water slowly. Stir. Cook to consistency of thick syrup. Volume is reduced about two-thirds.
3. This syrup will keep in a cool place for many weeks and is convenient to use in desserts and sauces.

Economical Chocolate Pudding (a variation of Blanc Mange)

- 1½ c. scalded milk
- 3 tbsps. cornstarch
- 3 tbsps. cocoa
- 1⅓ c. sugar
- 1⅛ tsp. salt
- 1½ c. cold milk
- 1 tsp. vanilla

1. Mix dry ingredients. Gradually add cold milk.
2. Add scalded milk. Cook over boiling water. Stir as mixture thickens.
3. Continue cooking, stirring occasionally for 10 minutes.
4. Cool in pot until pudding thickens slightly. Beat with Dover egg beater. Add vanilla. Pour into serving dishes. Chill. Serves 4.

GELATINE DESSERTS

Many delicious desserts can be made from unflavoured gelatine. Here are some jelly recipes with good fruit flavour.

	Lemon Jelly	Orange Jelly
gelatine	1 tbsps	1 tbsps.
cold water	¼ c.	¼ c.
boiling water	1¼ c.	½ c.
sugar	½ c.	½ c.
shavings of lemon rind from	1 lemon	1 lemon
lemon juice	¼ c.	3 tbsps.
orange juice, fresh or canned	—	¾ c.

1. Soak gelatine in cold water.
2. Boil water, sugar and rind, gently, in covered pan, 5 minutes.
3. Add syrup to gelatine and stir till all gelatine is dissolved.
4. Add fruit juice. Strain.
5. Pour into serving dishes or moistened moulds. Chill. Serves 4.

NOTE

1. **For Grapefruit Jelly, Grape Jelly or Apple Jelly** use recipe for Orange Jelly (above). Omit orange juice. Use ¾ c. grapefruit juice or ¾ c. grape juice or ¾ c. apple juice.
2. **For Jelly using leftover syrup from canned fruit** use recipe for Lemon Jelly (above). Omit boiling water and sugar. Use 1½ c. fruit syrup.

Whips

Use any of gelatine recipes (above).

Chill in mixing bowl until slightly thickened.

Beat with Dover egg beater until foamy.

Pour into serving dishes. Chill. May be served with Custard Sauce. See recipe, page 56.

Serves 5.

Sponges

Use any of gelatine recipes (above).

Chill in mixing bowl until slightly thickened. Beat with Dover egg beater until foamy. Combine with 2 stiffly beaten egg whites. Beat until mixture begins to set.

Pour into serving dishes. Chill. Serve with Custard Sauce. See recipe, page 56. Serves 5-6.

Jellied Fruit

Use any of gelatine recipes, page 60.

Chill, in mixing bowl, until slightly thickened.

Add 2 c. prepared fruit, such as sectioned oranges and grapefruit, canned peaches, pineapple, etc. All juice should be drained from fruit. Never use raw pineapple with gelatine.

BAKED DESSERTS

Dutch Apple Cake

recipe of Tea Biscuits, page 74

9 apples

$\frac{2}{3}$ c. brown sugar

2 tsp. cinnamon
butter

1. Grease 8" square cake pan and spread biscuit dough $\frac{1}{2}$ " thick in pan.
2. Pare and core apples. Cut in eighths and press lightly into dough.
3. Mix sugar and cinnamon and sprinkle over apples. Dot with butter.
4. Bake in hot oven, 400°, 10 minutes. Reduce temperature to 350°, and bake 15-20 minutes longer. Serve hot with cream or Lemon or Brown Sugar Sauce. See recipes, page 62.
Serves 6.

NOTE

Diced rhubarb or sliced peaches may be used in place of apples.

Fruit Roll

recipe of Tea Biscuits, page 74

1 pt. canned plums, cherries,
rhubarb or blueberries

1. Roll dough $\frac{1}{4}$ " thick.
2. Spread drained pitted fruit over dough.
3. Roll like a jelly roll.
4. Bake in hot oven, 400°, 30 minutes. Serve hot with Fruit Sauce. See recipe, page 62.
Serves 6-8.

Cottage Pudding

$\frac{1}{4}$ c. fat

$\frac{2}{3}$ c. sugar

1 egg, beaten

1 tsp. vanilla

$1\frac{3}{4}$ c. sifted pastry flour

$\frac{3}{4}$ tsp. baking powder

$\frac{1}{2}$ tsp. salt

$\frac{1}{2}$ c. milk

1. Line pan, 8" x 8" x 2", with waxed paper.
2. Cream fat. Add sugar gradually. Beat well. Add egg and vanilla. Beat.
3. Add mixed and sifted dry ingredients alternately with milk.
4. Bake in moderate oven, 350°, 35-45 minutes. Serve hot with Fruit, Lemon or Brown Sugar Sauce. See recipes, page 62.
Serves 6.

Upside-down Cake

recipe of Cottage Pudding, page 61

3 tbsp. butter
 $\frac{3}{4}$ c. brown sugar
fruit

1. Put butter in a casserole, $1\frac{1}{2}$ qt. size. Add sugar. Place in hot oven, 425° , until butter is melted.
2. On this arrange a layer of any desired cooked, drained fruit such as prunes, apricots, peaches or rhubarb. Apple rings may be used.
3. Cover with Cottage Pudding batter and bake.
4. Invert and serve hot with whipped cream, Fruit, Lemon or Brown Sugar Sauce (below). Serves 6.

DESSERT SAUCES

Fruit Sauce

1 tbsp. cornstarch
OR
2 tbsp. flour
 $\frac{1}{4}$ c. sugar
grated rind of $\frac{1}{2}$ lemon
1 c. syrup from canned fruit
juice of $\frac{1}{2}$ lemon, strained

1. Mix cornstarch, sugar and lemon rind.
2. Slowly add syrup. Stir.
3. Cook, stirring until sauce is thick and clear.
4. Serve hot, adding lemon juice just before serving.

Lemon Sauce

1 tbsp. cornstarch
OR
2 tbsp. flour
 $\frac{1}{3}$ c. sugar
grated rind of 1 lemon
1 c. cold water
 $1\frac{1}{2}$ tbsp. butter (optional)
juice of 1 lemon, strained

1. Mix cornstarch, sugar and lemon rind.
2. Slowly add water. Stir.
3. Cook, stirring until sauce is thick and clear.
4. Serve hot, adding butter and lemon juice just before serving.

Brown Sugar Sauce

1 tbsp. cornstarch
OR
2 tbsp. flour
 $\frac{2}{3}$ c. brown sugar
f.g. salt
1 c. cold water
2 tbsp. butter
1 tsp. vanilla

1. Mix cornstarch, sugar and salt.
2. Slowly add water. Stir.
3. Cook, stirring until sauce is thick and clear.
4. Serve hot, adding butter and vanilla just before serving.

Flour Mixtures

CAKES

Luck plays a very small part in cake making. The woman who turns out perfect cakes every time understands the principles of cake making. In this booklet, we are not attempting to give you a great variety of cake recipes. But we will try to explain in some detail the steps in cake making which produce perfect cakes, every time. Here are some tips which good bakers know.

INGREDIENTS

Flour

All flours are not the same. Flours are milled from different types of wheat and are suited to different types of baking. Cake and pastry flours are much better than other kinds for cake making. If all-purpose flour is substituted for pastry flour use 2 tbsp. less per cup.

Fat

Vegetable shortenings cream well and are satisfactory for cakes. The "emulsifier" type of shortening ("Swift'ning" is an example) is also satisfactory. Vegetable shortening or "emulsifier type" shortening were used to test flour mixture recipes in this book. If butter, margarine or lard are used, reduce liquid in recipe by 2 tbsp. for each cup of liquid.

Sugar

Use white sugar unless brown sugar is called for in the recipe. White sugar for cakes must be fine. Roll coarse sugar with a rolling pin. If sugar is lumpy, sift before using. To keep brown sugar moist and soft, leave a piece of bread or apple in the sugar jar.

Eggs

Egg whites whip best at room temperature when at least three days old. Egg whites will not beat stiffly if fat is present. Egg yolk (which contains fat) and even a small amount of fat on beater or bowl will prevent egg whites from beating stiffly.

Baking Powder

When the *kind* of baking powder is not stated in a recipe, the *amount* refers to single-acting baking powder (such as "Magic"). If we use double-acting baking powder (such as "Calumet") we may reduce the amount by almost one-half.

MEASUREMENT OF INGREDIENTS

Use standard measuring cups and spoons. We can buy a measuring cup and a set of spoons for a few cents. It is not economy to save a few cents on this simple equipment and waste food because of baking failures. All good modern recipes are based on standard measurements. For good results, every time, measure exactly. Measurements must be level. Use the blunt edge of a knife to level measurements.

To measure flour

Always sift flour before measuring. The homemaker who is "too busy" to sift flour before measuring, may add an extra half cup of flour to her cake and ruin the cake. Lift sifted flour lightly by spoonfuls into the measuring cup and level by drawing the edge of a knife across the top. Do not press flour or shake down into the cup.

To measure fat

Measure small amounts by tablespoons. To measure $\frac{1}{2}$ c. fat, first place $\frac{1}{2}$ c. water in standard cup. Then add fat, keeping it below the level of the water, until the level of the water is raised to the 1 c. mark. Drain off water. To measure $\frac{1}{3}$ c. fat, begin with $\frac{2}{3}$ c. water. This method gives quick accurate measurements.



To measure brown sugar, pack in standard cup so that sugar will hold shape of cup, when turned out.

To measure liquids

Place measuring cup on level surface. If you hold the cup in your hand it may slant and an inaccurate measurement result. Your eye should be at the same level as the liquid for accurate measurement.

To measure baking powder

Use a *dry* measuring spoon. Level with a knife. Too little or too much may give disappointing results. Keep baking powder tin tightly covered.

TEMPERATURE OF INGREDIENTS

All ingredients should be at room temperature when combined into a cake batter. At room temperature, fats cream best and egg whites beat to a greater volume. Cold eggs or cold milk may cause separation or curdling of the creamed mixture.

PANS

The size of cake pan makes a difference. If you have no pan of the size given in a recipe, select a pan of about the same volume. Fill cake pans only half full of batter for best results. Cake should rise just to the top of the pan in order to brown well and give finest quality.

Preparing pans

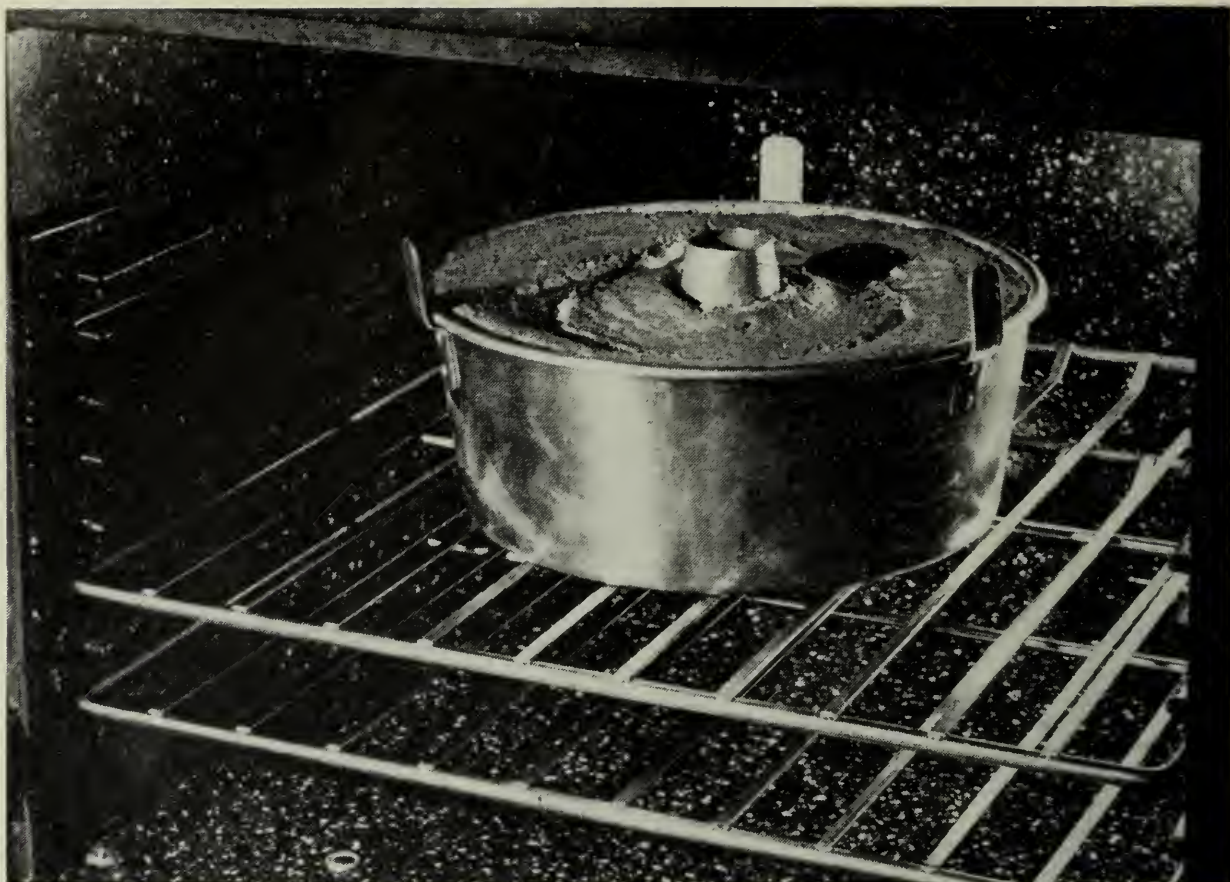
Prepare pans before starting to mix cake. Pans for sponge, angel or chiffon cakes: Do not grease or line with paper. Other cake pans: Line bottom of pan with wax paper. Do not grease sides. A larger cake results when sides of pan are not greased. Special care is necessary in preparing pans for certain cakes, such as fruit cake and gum drop cake.



Fill cake pans only half-full of batter.



Your cake will look handsome if you spread the batter way into the corners.



When you are baking one cake, place on centre of rack in centre of oven.



When two cakes are baked at a time, place both on same rack. Arrange so that pans do not touch each other or walls of oven.



When baking three cakes, place two pans on bottom shelf so they are not touching each other or oven walls. Third cake is placed on top shelf, not directly above either of others.



When baking four cakes, place two on lower shelf and two on upper shelf. Arrange so that no cake is directly above another and the pans are not touching each other or oven walls.



When the tester comes out clean, your cake's done!

OVEN MANAGEMENT

See that the racks are in place before heating the oven. Start heating the oven far enough in advance to have a steady even heat of the right temperature by the time your baking is ready.

Usually the heat is even at the centre of the oven. If only one rack is used, place near the centre. If two racks are needed, place one slightly below the centre, one slightly above.

Do not place one pan directly above another. Do not crowd the oven full. Do not place pans too near the oven walls or too close together. The heat must flow freely on all sides of each baking pan to result in even baking.

Every good recipe gives the best temperature and baking time for the product we are making. It is most important to adjust the heat to keep that exact temperature. Not all thermometers on oven doors are exact. Inexpensive oven thermometers can be purchased and are worth their weight in gold.

TESTS WHEN YOUR CAKE IS BAKED

1. Cake (except sponge-type cake) has shrunk slightly from sides of pan.
2. Cake has risen to its full height and has a delicately browned crust.
3. A wire cake tester or toothpick inserted near the centre will come out clean and dry.
4. The top surface, when pressed lightly with finger, will spring back.

NOTE: For chocolate cake or a very rich cake, use only Test 1 or 2.



Off with the paper, as soon as your cake is removed from the pan!

Cooling

As soon as butter-type cake is done, remove from oven and place pan on cake rack. Butter-type cakes should cool in pan 10 minutes.

Loosen cake from sides of pan with spatula and turn out on cake rack.

Remove paper from bottom and finish cooling, right side up.

Fruit cakes should be left in pans until cold as they are heavy, yet tender, when hot.

As soon as sponge-type cake is removed from the oven, turn pan upside-down, leaving an air space between the pan and the table top. Do not disturb until cake is cool.

Never cut cake when hot.

Storing

Cakes may be stored in a covered tin or may be covered and stored in the refrigerator.

After serving part of a cake, cover cut surface with wax paper. This paper may be held securely in place with toothpicks.

CAKE FROSTINGS

Temperature of cake

Cake should always be cold before frosting.

Preparation of cake

Brush off loose crumbs. Any ragged edges should be trimmed with scissors.

Equipment

Use spatula for frosting.

Garnishes

A wide choice of garnishes may be used to give variety to your favourite frostings.

Here are a few:	browned cocoanut	grated orange or lemon rind
	tinted cocoanut	tinted sugar
	nuts, chopped or halved	toasted slivered almonds
	melted chocolate	sifted cinnamon
	chocolate chips	maraschino cherries

Butter Frosting

2 tbsp. butter
about 1 c. icing sugar
2 tbsp. liquid (such as cream, fruit
juice, strong coffee)
flavouring (such as vanilla, maple,
peppermint)

1. Cream butter. Add some sugar. Beat. Add liquid, remaining sugar and flavouring.
2. Beat well.

Butterscotch Frosting

1 egg white
 $\frac{1}{8}$ tsp. salt
2 tbsp. cold water
1 c. brown sugar
1 tsp. vanilla
OR
 $\frac{1}{4}$ tsp. maple flavouring

1. Beat egg white in top of double boiler with good Dover egg beater.
2. When whites began to stiffen, sprinkle salt over surface and gradually add cold water and brown sugar, which must be free from lumps.
3. Place top of double boiler over gently boiling water and continue to beat about 7 minutes, until mixture will stand in peaks. Remove from heat.
4. Cool slightly, add flavouring and spread on cake.

Prize Cake

$\frac{1}{3}$ c. shortening	$1\frac{3}{4}$ c. sifted cake flour
1 c. sugar	$2\frac{1}{2}$ tsp. baking powder
2 eggs	$\frac{1}{2}$ tsp. salt
$\frac{1}{2}$ tsp. vanilla	$\frac{2}{3}$ c. milk

Read general hints on cake making, pages 63 to 69.

Remove shortening, milk and eggs from the refrigerator so that all ingredients will be at room temperature when combined into cake batter.

1. Preheat oven to 350°.
2. Line the bottom of pan 8" x 8" x 2" with wax paper. Do not grease sides of pan.
3. Beat shortening until light and fluffy.
4. Gradually add sugar, about 1 tablespoon at a time. Beat well, about 1 minute. Repeat until all sugar is mixed with fat. Scrape spoon and bowl frequently during creaming.
5. Separate egg yolks and whites. Beat yolks with fat mixture. Add vanilla. Beat well.
6. Measure sifted flour. Sift with baking powder and salt.
7. Beat egg whites until stiff but do not overbeat. Beaten egg whites should have a shiny appearance. Set aside.
8. Add a few tablespoons of flour mixture to fat mixture. Stir until flour is dampened. Beat for 30 seconds.
9. Add milk alternately with flour mixture. Add about $\frac{1}{5}$ of milk at one time. With a few gentle strokes, mix it slightly with other ingredients.
10. Repeat this addition of flour and milk alternately, using the same amounts and method of combining. Shorten beating time as mixing nears completion. The last addition should be flour. Work quickly.
11. Fold in beaten egg whites.
12. Immediately turn batter into prepared pan.
13. Bake in moderate oven, 350°, 35-40 minutes. The cake should have a delicately browned crust and should have shrunk slightly from sides of pan.
14. Leave in pan 10 minutes after removal from oven.
15. Loosen sides and remove from pan. Remove paper and turn cake right side up on rack to finish cooling.

Spice Cake

Use recipe of Prize Cake (above). Sift with the dry ingredients 1 tsp. cinnamon, $\frac{1}{4}$ tsp. nutmeg and $\frac{1}{4}$ tsp. allspice.



Melt chocolate over hot water to prevent scorching. To avoid waste, use a small bowl and remove every bit of melted chocolate with a scraper.

Chocolate Cake I

- $\frac{1}{2}$ c. shortening
- $1\frac{1}{3}$ c. sugar
- OR
- $1\frac{1}{2}$ c. brown sugar
- 2 eggs, beaten
- 1 tsp. vanilla
- 3 squares unsweetened chocolate, melted
- 2 c. sifted cake flour
- 1 tsp. soda
- $\frac{3}{4}$ tsp. salt
- 1 c. plus 2 tbsp. milk

1. Follow directions for Prize Cake, page 71.
2. Prepare two 9" layer cake pans $1\frac{1}{2}$ " deep or one pan 13" x 9" x 2".
3. Cream shortening. Add sugar gradually. Beat well.
4. Add eggs and vanilla. Beat well.
5. Add chocolate. Beat well.
6. Add sifted dry ingredients alternately with milk.
7. Bake in moderate oven, 350°, in layer cake pans, 30 minutes; in 13" x 9" x 2" pan, 40 minutes.

Chocolate Cake II (using cocoa)

Use recipe of Chocolate Cake (above).
 Use $\frac{2}{3}$ c. shortening.
 Sift $\frac{1}{2}$ c. cocoa with dry ingredients.
 Omit chocolate.

WORTH REMEMBERING

Use 3 tbsp. cocoa plus 1 extra tbsp. fat to replace 1 oz. chocolate.

To sour fresh milk, add 1 tbsp. vinegar to 1 c. sweet milk. Let stand in warm place a few minutes.

Lemon Chiffon Cake

		FOR 10" TUBE CAKE	FOR 8" OR 9" SQUARE CAKE
INGREDIENTS		(20 SERVINGS)	(10 SERVINGS)
A.	sifted cake flour	2 $\frac{1}{4}$ c.	1 c. plus 2 tbsp.
	sugar	1 $\frac{1}{2}$ c.	$\frac{3}{4}$ c.
	baking powder	1 tbsp.	1 $\frac{1}{2}$ tsp.
	salt	1 tsp.	$\frac{1}{2}$ tsp.
B.	cooking oil	$\frac{1}{2}$ c.	$\frac{1}{4}$ c.
	unbeaten egg yolks	5	2
	grated lemon rind	3 tbsp.	1 $\frac{1}{2}$ tbsp.
	lukewarm water	$\frac{3}{4}$ c.	$\frac{1}{4}$ c. plus 2 tbsp.
C.	egg whites	1 c. (7-8 whites)	$\frac{1}{2}$ c. (4 whites)
	cream of tartar	$\frac{1}{2}$ tsp.	$\frac{1}{4}$ tsp.

METHOD

1. Sift ingredients in "A" into mixing bowl.
2. Make a "well" in centre of dry ingredients and add, in order, the ingredients in "B". Beat until perfectly smooth.
3. Measure ingredients in "C" into large mixing bowl. Beat with Dover egg beater until whites form *very stiff* peaks.
4. Pour egg yolk mixture gradually over beaten egg whites, folding gently with rubber scraper or spatula. Blend only enough to make a uniform mixture.
5. Pour immediately into *ungreased* pan.
For 10" tube cake, use pan 10" in diameter, 4" deep. Bake in slow oven, 325°, 1 $\frac{1}{4}$ hours. For square cake, use pan 9" x 9" x 2" or 8" x 8" x 2". Bake in a slow oven, 325°-350°, 30 minutes. When baked, top springs back when lightly touched.
6. Immediately turn pan upside-down, placing funnel or small bottle in neck of tube pan or resting edges of square pan on two other pans. Let hang, free of table, until cold. Loosen sides and tube with spatula. Turn pan over and hit edges sharply.

Gingerbread

- $\frac{1}{4}$ c. shortening
- $\frac{1}{2}$ c. brown sugar
- 2 eggs, beaten
- $\frac{1}{2}$ c. molasses
- 1 $\frac{1}{2}$ c. sifted pastry flour
- 1 $\frac{1}{2}$ tsp. ginger
- $\frac{1}{8}$ tsp. salt
- $\frac{3}{4}$ tsp. soda
- $\frac{1}{2}$ c. boiling water

1. Prepare 9" square pan.
2. Cream shortening. Add sugar gradually. Beat well.
3. Add eggs and molasses, slowly. Beat well.
4. Gradually add sifted dry ingredients.
5. Add boiling water quickly. Do not overmix.
6. Immediately turn batter into prepared pan.
7. Bake in slow oven, 300°-325°, 25-30 minutes.

WORTH REMEMBERING

$\frac{1}{2}$ tsp. soda is used with 1 c. sour milk and can replace 2 tsp. baking powder, when sour milk is substituted in a sweet milk recipe.

With glass baking utensils, a 25° lower oven temperature or a shorter baking time is recommended.

TEA BISCUITS

Tea Biscuits

- 2 c. sifted pastry flour
- 4 tsp. baking powder
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{3}$ c. cold fat
- about $\frac{2}{3}$ c. milk

1. Sift dry ingredients into mixing bowl.
2. Cut in fat with two knives or pastry blender. The fat should be evenly cut into pieces about the size of large peas.
3. Pour milk into centre of flour mixture. Stir until mixture leaves sides of bowl.

NOTE

If the proportion of milk to flour is exactly right, the bowl will be clean and the dough will be moist but not sticky. If too much milk is used, some dough will stick to the bowl. A little extra flour on the kneading board may help to remedy this. If you judge that dry particles are going to be left in the bowl, add a few drops more milk during mixing.

4. Knead gently on lightly floured surface, 1 minute. Pat to 1 inch thickness.
 5. Cut with cookie cutter or knife.
 6. Bake on ungreased pan, in a very hot oven, 450° - 500° , 12 minutes. Test by breaking a biscuit open to be sure it is cooked through.
- Yields 10 biscuits, 2" in diameter.

WORTH REMEMBERING

When not mixed enough, biscuits have a rough, mottled surface and do not rise properly. When overmixed or kneaded too long, they are tough.

Whole Wheat Tea Biscuits

Use recipe of Tea Biscuits (above).

Use 1 c. sifted pastry flour and 1 c. sifted whole wheat flour to replace 2 c. pastry flour.

Use $\frac{2}{3}$ c.- $\frac{3}{4}$ c. milk.

Wheat Germ Tea Biscuits

Use recipe of Tea Biscuits (above).

Use $1\frac{1}{2}$ c. sifted pastry flour and $\frac{1}{2}$ c. wheat germ to replace 2 c. pastry flour.

Cheese Tea Biscuits

Use recipe of Tea Biscuits (above).

Add $\frac{2}{3}$ c. grated cheese after cutting in fat.

A good tea biscuit is

1. Golden brown on top and bottom
2. Smooth on top and not mottled
3. Light
4. Double its unbaked size
5. Tender
6. Flaky

Ever-ready Mix for Tea Biscuits, Pancakes, Waffles and Muffins

Easy to prepare. Quick and easy to use. Less expensive than commercially prepared mixes.

- 6 c. sifted pastry flour
- 6 tsp. double-acting baking powder (such as "Calumet")
- 3 tsp. salt.
- 1 c. or 1/2 lb. fat

1. Measure 3 c. sifted flour into sifter. Add 3 tsp. baking powder and 1 1/2 tsp. salt. Sift dry ingredients into large bowl.
2. Repeat (1).
3. Cut in fat with pastry blender or two knives until mixture resembles coarse meal.
4. Store in two quart jars. Cover with two thicknesses of wax paper, held in place with the metal screw-top. Keep in a cold place. Keeps well for at least 4 weeks. If a shortening which does not require refrigeration is used ("Swift'ning" and "Crisco" are examples) the Mix may be stored on a *cupboard shelf* for at least 12 weeks.

For Tea Biscuits

- 2 c. Ever-ready Mix (above)
- about 1/2 c. milk

1. Measure Mix into bowl.
2. Add milk.
3. Complete, according to directions for Tea Biscuits. See recipe, page 74.
Yields 10 biscuits.

For Pancakes or Waffles

- 2 c. Ever-ready Mix (above)
- 2 eggs, well beaten
- 1 1/4 c. milk

1. Measure Mix into bowl.
2. Add milk to eggs.
3. Gradually add liquid to Mix. Stir only enough to dampen flour.
4. Bake on hot griddle or waffle iron.
Yields 16-4" pancakes or 4-7" waffles.

For Muffins

- 2 c. Ever-ready Mix, page 75
- 1 egg, well beaten
- 2 tbsp. sugar
- $\frac{3}{4}$ c. milk

1. Measure Mix into bowl.
2. To egg, add sugar and milk. Stir until sugar dissolves.
3. Add liquid to Mix. Stir only until dry ingredients are dampened.
4. Bake in hot oven, 425°, 20 minutes.

Yields 8 large muffins.

For Marmalade Muffins

Use recipe of Muffins (above).

Omit sugar.

Mix 3 tbsp. orange marmalade with milk.

Before baking, top each muffin with $\frac{1}{2}$ tsp. marmalade.

MUFFINS

Most of the faults in muffins come from overmixing. The object in mixing is merely to moisten the flour, not to produce a smooth creamy batter as in making cake. *A muffin batter should be lumpy.* Muffins should never be beaten. Mixing the dry and wet ingredients is done by drawing the flour into the liquid.

Best results are obtained when egg and milk are at room temperature. When melted fat is added to very cold milk and eggs, it becomes solid. Solid fat is not evenly distributed through the batter and poorer muffins result. Salad oil, in place of melted fat, is excellent for muffins.

When a muffin has a shiny surface, rises in peaks, is uneven in shape or has large uneven holes inside, it has been overmixed.

A good muffin is

1. Even in shape
2. Well browned
3. Rough, pebbly and slightly rounded on top
4. Even in texture (no tunnels or large uneven holes inside)
5. Light

Muffins

- 2 c. sifted pastry flour
- $3\frac{1}{2}$ tsp. baking powder
- $\frac{1}{2}$ tsp. salt
- 3 tbsp. sugar
- 3 tbsp. fat, melted
- 1 egg, beaten
- 1 c. milk

1. Grease 10 muffin tins.
2. Sift dry ingredients into mixing bowl.
3. Mix all wet ingredients and pour into centre of flour mixture. Mix only enough to dampen all flour. Do not overmix. Mixture should be lumpy. Mix quickly.
4. Two-thirds fill muffin tins. Bake in hot oven, 400°, 20 minutes. Serve warm.



Hot muffins can "make" a meal. Cover them snugly to keep hot at the table.

Raisin or Currant Muffins

Use recipe of Muffins, page 76.

Add $\frac{1}{4}$ c. raisins or currants to sifted dry ingredients.

Whole Wheat Muffins

Use recipe of Muffins, page 76.

Use 1 c. sifted pastry flour and 1 c. sifted whole wheat flour in place of 2 c. pastry flour.

Wheat Germ Muffins

- $1\frac{2}{3}$ c. sifted pastry flour
- 5 tsp. baking powder
- 1 tsp. salt
- 3 tbsp. sugar
- $\frac{2}{3}$ c. wheat germ
- $\frac{1}{3}$ c. fat, melted
- 2 eggs, beaten
- 1 c. milk

1. Grease 12 muffin tins.
2. Sift flour, baking powder, salt and sugar into mixing bowl.
3. Stir in wheat germ.
4. Mix all wet ingredients and pour into centre of flour mixture. Mix only enough to dampen all flour. Mixture should be lumpy. Mix quickly.
5. Two-thirds fill muffin tins. Bake in hot oven, 400° , 15-20 minutes.

Serve warm.

Bran Muffins

- 2 c. sifted pastry flour
- 2 tsp. salt
- 1½ tsp. soda
- 1 tsp. baking powder
- 4 tbs. sugar
- 2 c. cooking bran
- 1 c. raisins (optional)
- 2 tbs. fat, melted
- 1 egg, beaten
- 2 c. sour milk
- ⅓ c. molasses

1. Grease 12 large muffin tins.
2. Sift flour, salt, soda, baking powder and sugar into mixing bowl.
3. Stir in bran and raisins.
4. Mix all wet ingredients and pour into centre of flour mixture. Stir only enough to dampen flour. Mixture should be lumpy. Mix quickly.
5. Two-thirds fill muffin tins. Bake in hot oven, 425°, 25 minutes. Serve warm.

WORTH REMEMBERING

Here are the "secrets" of perfect muffins, every time!

Do not overmix.

Use melted fat which has been cooled after melting but is still liquid.

Use milk and eggs at room temperature.

COOKIES

Butterscotch Cookies

- ½ c. fat (part butter adds flavour)
- 1½ c. brown sugar
- 2 eggs, unbeaten
- 1 tsp. vanilla
- 3½ c. sifted all-purpose flour
- OR
- 4 c. sifted pastry flour
- 1 tsp. salt
- ½ tsp. cream of tartar
- 1 tsp. baking soda
- 1 c. walnuts, finely chopped (optional)

1. Cream fat. Add sugar gradually. Beat well.
2. Add eggs and vanilla. Beat.
3. Sift the dry ingredients. Add to fat mixture. Mix well. Add nuts.
4. Cover and chill.
5. Form dough into 2" roll, wrap well in wax paper. Leave overnight in cold place.
6. Cut with sharp knife in ⅛" slices.
7. Bake on greased baking sheet in moderate oven, 375°, 10 minutes.
8. When cold, store in tightly covered tin.
Yields 5 doz. cookies, 2½" in diameter.

NOTE

The uncooked dough, if well wrapped, may be kept for several weeks in the refrigerator. Fresh cookies may be baked quickly, as required.

Rolled Oats Cookies

- $\frac{2}{3}$ c. fat
- $1\frac{2}{3}$ c. brown sugar
- 2 eggs, unbeaten
- 1 tsp. vanilla
- $\frac{1}{2}$ c. dates, finely chopped
- $\frac{1}{2}$ c. raisins, chopped
- 1 c. sifted all-purpose flour

OR

- 1 c. plus 2 tbsp. sifted pastry flour
- 1 tsp. salt
- 1 tsp. baking soda
- 3 c. quick-cooking rolled oats

1. Cream fat. Add sugar gradually. Beat well.
 2. Add eggs and vanilla. Beat well. Add fruit.
 3. Mix and sift the flour, salt and soda.
 4. Add to fat mixture. Mix well.
 5. Add rolled oats.
 6. Wrap dough in wax paper and chill overnight.
 7. Roll small balls of dough between hands and place on greased baking sheet.
 8. Bake in moderate oven, 350° , 12 minutes.
 9. When cold, store in tightly covered tin.
- Yields 4 doz. cookies, $2\frac{1}{2}$ " in diameter.

NOTE

The uncooked dough, if well wrapped, may be kept for several weeks in the refrigerator. Fresh cookies may be baked quickly, as required.

Raisin Macaroons

- 1 c. raisins, chopped
- 1 c. cornflakes, slightly packed
- 3 egg whites
- f.g. salt
- $\frac{2}{3}$ c. very fine sugar
- 1 tsp. vanilla

1. Mix raisins and cornflakes.
 2. Beat egg whites stiff.
 3. Sprinkle with salt. Add flavouring and gradually add sugar. Continue to beat until mixture is very stiff.
 4. Add raisins and cornflakes.
 5. Drop from teaspoon on greased baking sheet. Top with piece of green or red maraschino cherry, if desired.
 6. Bake in slow oven, 325° , 20 minutes. Macaroons are dry on surface when baked.
 7. Cool slowly on pan. Loosen before cold. Store in tightly covered tin.
- Yields 2 doz. macaroons, 2" in diameter.

Matrimonial Squares

- 1½ lb. dates
- 1½ c. boiling water
- grated rind of 1 lemon
- juice of 1 lemon
- 1 c. sifted pastry flour
- 1 c. sifted whole wheat flour
- ¼ tsp. salt
- 1 tsp. baking powder
- ½ tsp. baking soda
- ½ c. brown sugar
- 2½ c. quick-cooking rolled oats
- 1 c. fat

1. To dates, add water and lemon rind. Cook over low heat until thick. Cool. Add lemon juice.
2. Sift into mixing bowl flours, salt, baking powder, soda and sugar. Add oats.
3. Cut in fat, as for tea biscuits.
4. Spread one-half flour mixture in greased pan, 12" x 8" x 2". Press down. Spread with dates. Cover with remaining flour mixture. Pat to make smooth.
5. Bake in moderate oven, 350°, 1 hour.
6. Cool in pan. Cut in squares. Matrimonial cake will keep for several weeks.

NOTE

One beaten egg mixed with 2 tbsp. water may be brushed over top of cake before baking, to prevent crumbling.

PASTRY

Good pastry is

1. Tender but not crumbly
2. Flaky
3. Rough and blistered on surface
4. Golden brown around edge
5. Lighter brown on bottom
6. Crisp

PASTRY

Ingredients (for 9" shell, 1¼" deep)

- 1½ c. sifted pastry flour
- ¾ tsp. salt
- ½ c. cold fat
- about 3 tbsp. cold water

Adding the fat

1. Use cold fat.
2. Use knives or pastry blender to cut fat into sifted flour and salt.
3. Cut about ⅔ of fat in finely. The mixture becomes fine as meal. Then it grows coarser until particles tend to lump together.
4. Chop in the remaining fat till it is in pieces the size of large peas.
5. Work quickly (about 1 minute to combine fat and flour for one pie).

Adding water

Too much water makes tough pastry.

1. Use cold water.
2. Sprinkle a *small amount* of water over surface of flour-fat mixture. Even experienced cooks often have better results by sprinkling water from a shaker.
3. Each time water is added, try to put it on undampened flour.
4. Run a fork along the bottom of the bowl and bring it up with a tossing motion through the mixture.
5. Press dampened particles gently to see if they stick together. Remove lumps from the bowl as they form.
6. Work quickly. Try to add the water for 1 pie in not more than 2 minutes.

Rolling the dough

1. Press ball of dough into a cake.
The dough should be easy to handle.
Too sticky dough is the result of too much water.
Too crumbly dough is the result of too little water.
Press outer edges of cake firmly together so that they do not crack.
Dough may be chilled before rolling.
2. Use very little flour, roll *lightly* into circular sheet of uniform thickness.
3. For pan $1\frac{1}{4}$ " deep, roll a circle $2\frac{1}{2}$ " in diameter greater than outside diameter of pan.
If pastry sticks, loosen with spatula and dust flour on board.

Fitting pastry to pan

To lift pastry, fold one half lightly over other half. Place loosely in pie pan; open out and pat down to fit pan well.

For pie shell

1. Trim with scissors so that pastry extends about 1" beyond edge of pan. The extra inch of pastry is folded back and under to form a standing rim. Then flute with fingers for an attractive finish.
2. Prick with fork.
3. Bake in a very hot oven, 450° , 10-15 minutes or until golden brown around edge.

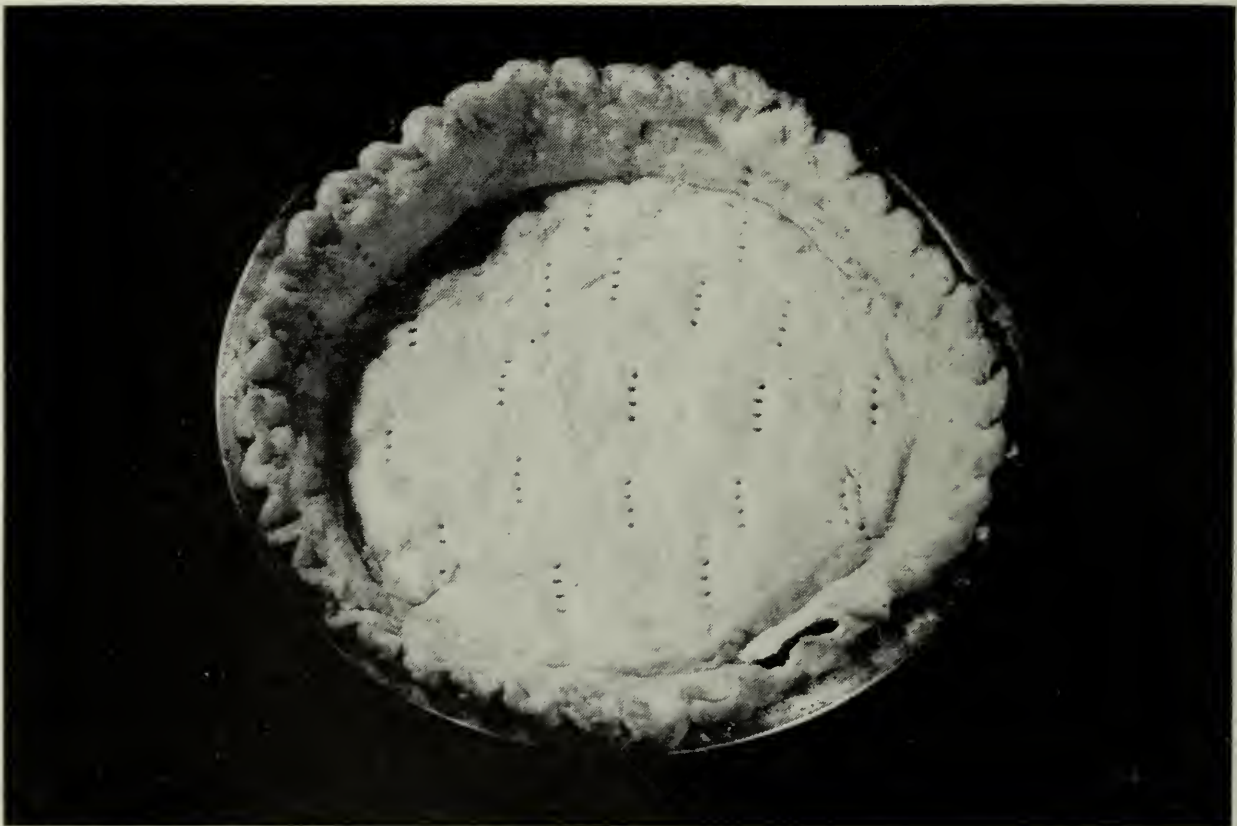
For two-crust 9" pie

1. Double recipe of Pastry, page 80.
2. Roll half of dough and line pie pan. Trim with scissors allowing $\frac{1}{2}$ " of pastry to extend over edge.
3. Add filling.
4. Roll out remaining pastry. Fold in half. Make several gashes to allow escape of steam and place over filling.
5. Allow top crust to overlap bottom crust.
6. Fold top crust under the lower.
7. Crimp edges.
8. Bake according to directions in recipes.

LET'S COOK OUR PASTRY RIGHT
OVEN TEMPERATURE MAKES A DIFFERENCE



Pie shell baked at 450° has good shape, uniform colour and small regular blisters.



*Pie shell baked at too low a temperature has poor shape and has shrunk into bottom of pan.
It has a less flaky appearance and is pale in colour.*

LET'S COOK OUR PASTRY RIGHT

OVEN TEMPERATURE MAKES A DIFFERENCE



Burned pie shell baked at too high a temperature.

Whole Wheat Pastry (for two-crust, 9" pie, 1 1/4" deep)

Whole wheat pastry has more flavour and food value than pastry made with all white flour. Use whole wheat pastry often, especially with apple, raisin or pumpkin filling.

- 1 1/2 c. sifted pastry flour
- 1 1/2 c. sifted whole wheat flour
- 1 1/2 tsp. salt
- 1 c. cold fat
- about 6 tbsp. cold water

1. Follow general directions for Pastry. See page 80.

Ever-ready Pie Mix

Quickly prepared. Handy to use. Cheaper than commercially prepared pie mix.

- 6 c. sifted pastry flour
- 3 tsp. salt
- 1 lb. cold fat

1. Cut in fat, as for Pastry. See recipe, page 80.
2. Store in jar, covered with double thickness of wax paper, in cold place.
3. Use 1 1/2 c. Mix for 9" pie shell. Add about 2 1/2 tbsp. water. Use 3 c. Mix for two-crust pie. Add about 5 tbsp. water.
4. Finish according to directions for Pastry. See page 81.

Meringue

- 2 egg whites
- $\frac{1}{8}$ tsp. salt
- $\frac{1}{2}$ tsp. vanilla
- 4 tbsp. fine sugar

1. Beat egg whites until frothy. (For best results, eggs should be at least 3 days old and at room temperature.)
2. Add salt and vanilla and continue beating until eggs form a thick foam.
3. Add sugar, a tablespoon at a time, beating after each addition.
4. Continue beating until meringue stands in peaks when beater is raised out of mixture.
5. Spread a small amount of meringue around edge of filled pie shell, allowing no space between edge of pie shell and meringue. Pile rest of meringue in centre and spread lightly to meet edge.
6. Bake in slow oven, 325° - 350° , about 15 minutes.

PIE FILLINGS

Cream Filling

- 2 c. scalded milk
- 4 tbsp. cornstarch
- $\frac{2}{3}$ c. sugar
- $\frac{1}{4}$ tsp. salt
- 3 egg yolks, beaten
- 2 tbsp. butter
- $\frac{1}{2}$ tsp. vanilla

1. Mix cornstarch, sugar and salt.
2. Gradually add scalded milk.
3. Cook over boiling water. Stir as mixture thickens. Cook 10 minutes more. Stir occasionally.
4. Combine some of hot mixture with egg yolks. Stir into filling. Cook and stir 5 minutes.
5. Add butter and vanilla. Cool.
6. Pour cooled mixture into cooled baked 9" pie shell.
7. Top with Meringue (above) or whipped cream.

Banana Cream Filling

recipe of Cream Filling (above)

2 or 3 bananas

1. Slice bananas into cooled baked shell.
2. Pour cold Cream Filling over bananas.
3. Top with Meringue (above) or whipped cream and additional sliced bananas.

Cocoanut Cream Filling

recipe of Cream Filling, page 84

1 c. moist shredded cocoanut

1. Add cocoanut to Cream Filling after vanilla.
2. Top with Meringue, page 84 or whipped cream sprinkled with browned cocoanut.

To brown cocoanut

Spread in thin layer on pan. Brown in hot oven, 400°. Watch carefully and shake pan frequently to prevent burning.

Lemon and Orange Filling

1/2 c. scalded milk
1 c. sugar
6 tbsp. flour
2 tbsp. cornstarch
1/4 tsp. salt
1 c. water
rind of 1 orange
rind of 1/2 lemon
2 egg yolks, beaten
1 whole egg, beaten
1 tbsp. butter
1/2 c. mixed orange and lemon juice

1. Mix sugar, flour, cornstarch and salt.
2. Slowly add water and milk. Add rind.
3. Cook over boiling water. Stir as mixture thickens. Cook 10 minutes more. Stir occasionally.
4. Combine some of hot mixture with eggs. Stir into filling. Cook and stir 5 minutes.
5. Add butter. Cool slightly. Add fruit juices.
6. Pour cooled filling into cooled baked 9" pie shell. Cover with Meringue. See recipe, page 84.

Pumpkin Filling

1/2 c. scalded milk
1 tbsp. flour
1 c. sugar
1 tsp. ginger
1 tsp. cinnamon
1/8 tsp. nutmeg
1/2 tsp. mace
1/4 tsp. salt
1 1/2 c. pumpkin
3 eggs, beaten

1. Mix flour, sugar, spices and salt.
2. Add pumpkin.
3. To eggs, add milk and pumpkin mixture. Stir well.
4. Pour into 9" pie plate, 1 1/4" deep, lined with pastry.
5. Bake in very hot oven, 450°, about 10 minutes and then reduce temperature to 350° and bake until filling is set, about 30 minutes.

Custard Pie

recipe of Pastry, page 80

- 2 c. scalded milk
- $\frac{1}{2}$ c. sugar
- $\frac{1}{2}$ tsp. salt
- 1 tbsp. flour
- 2 eggs, beaten
- 1 tsp. vanilla
- $\frac{1}{2}$ tsp. nutmeg

1. Bake pie shell in hot oven, 450° , about 12 minutes.
2. Mix sugar, salt and flour. Add to eggs. Mix well.
3. When pie shell is almost baked, combine milk with egg mixture. Add vanilla.
4. As soon as pie shell is baked, pour about three-fourths of filling into hot crust. Set pie on oven rack and add remaining filling. Sprinkle nutmeg over surface.
5. Bake in slow oven, 325° , about 30 minutes, until a knife, run into centre of filling comes out clean. Cool.

Apple Filling

- 5 c. tart apples, thinly sliced
- $\frac{3}{4}$ c. sugar
- 1 tsp. cinnamon (optional)
- $\frac{1}{4}$ tsp. nutmeg (optional)
- 2 tbsp. butter

1. Combine all ingredients except butter and fill 9" pie pan lined with pastry.
2. Dot with butter.
3. Complete according to method for two-crust pies, page 81.
4. Bake in hot oven, 425° , 35 minutes or until crust is golden brown and apples are tender.

Raisin Filling

- 1 orange
- 1 lb. raisins
- $2\frac{1}{2}$ c. boiling water
- 3 tbsp. sugar
- $\frac{1}{2}$ tsp. nutmeg
- 2 tbsp. flour
- $\frac{1}{2}$ tsp. salt

1. Cut all rind from orange and dice rind very finely.
2. Simmer rind, raisins and water, covered, about 10 minutes.
3. Mix dry ingredients and combine with raisin mixture.
4. Cook and stir until thick.
5. Add chopped orange pulp.
6. This filling may be cooled and used
 - (1) in baked pie shell topped with Meringue, page 84, or whipped cream.
 - (2) in two-crust pies. Bake in hot oven, 425° , 30-35 minutes.

Canned Fruit Filling

Any canned fruit may be used in this recipe.

- 3 tbsp. cornstarch
- $\frac{2}{3}$ c. sugar
- $\frac{1}{4}$ tsp. salt
- $\frac{1}{2}$ c. fruit syrup
- grated rind of 1 lemon (optional)
- 2 c. canned fruit, drained and tightly packed
- 1 tbsp. butter
- juice of 1 lemon (optional)

1. Mix cornstarch, sugar and salt.
2. Add syrup and lemon rind and cook and stir until mixture is thick.
3. Add fruit and butter, stirring carefully to prevent breaking up fruit.
4. Add lemon juice.
5. This makes sufficient filling for 9" pie, $1\frac{1}{4}$ " deep. To complete pie, see method for two-crust pies, page 81.
6. Bake in hot oven, 425°, 35 minutes.

Fresh Fruit Pies

Sour Cherry or Raspberry

- 1 qt. sour cherries ($2\frac{1}{2}$ c. after pitting)
- OR
- $1\frac{1}{2}$ pt. red raspberries
- $\frac{3}{4}$ c. sugar
- 3 tbsp. flour

Blueberry

- 1 qt. blueberries
- $\frac{1}{2}$ c. $\frac{3}{4}$ c. sugar
- 2 tbsp. flour

1. See method for two-crust pie, page 81.
2. Mix together sugar and flour. Spread $\frac{1}{4}$ of this mixture over bottom crust.
3. Alternate layers of fruit and sugar-flour mixture.
4. Bake in hot oven, 425°, 20 minutes. Then lower oven temperature to 350° and bake about 20 minutes or until fruit is tender.

Beverages

MILK

Let's remember to include milk as a beverage with our meals. Number one place in Canada's Food Rules is reserved for milk. You will find Canada's Food Rules on page 4.

Some milk may be used in cooking. However adults are advised to drink some as a beverage at least once a day. Of course, children should drink it regularly.

Here's how to store milk

Keep it clean, cold, covered and away from the sunlight.

Here's how to heat milk

When heating milk, you can avoid scorching by using a double boiler. If the milk is not heated in a double boiler, always use low heat. Stir occasionally to prevent sticking. Bring to the boiling point, but do not boil. A cover on the pan during heating helps prevent a skin from forming on the top of the milk. If a skin does form, stir or beat it into the milk as it contains valuable minerals and vitamins.



"One for the pot!"

TEA

Here's how to make a good cup of tea

1. Use fresh water and bring the water to a strong bubbling boil.
2. Preheat the teapot before making the tea. A heated teapot prevents tea from cooling too quickly and keeps it at the proper temperature for the right length of time.
3. Measure tea: 1 tsp. per person and "one for the pot". If you use tea bags, follow the directions that come with them.
4. Add 1 c. boiling water for each person. Bring the pot to the kettle rather than the kettle to the pot.
5. Brew the tea five minutes. The tea may be stirred slightly and then poured off the leaves into another heated pot.

COFFEE

1. Buy fresh coffee and keep it tightly covered. Buy only one week's supply at a time. Coffee will have lost half its flavour by the end of the week.
2. Buy a grind suitable to the method used.
 - (a) Buy finely ground for drip and silex method.
 - (b) Buy medium ground for steeped or percolated method.
 - (c) Buy coarsely ground for cold water method.
3. Clean your coffee maker.
 - (a) Wash with soap and very hot water to eliminate oily film.
 - (b) Rinse thoroughly with clean water.
4. Measure accurately. Be uniform in measurement.
 - (a) For weak coffee, use 1 tbsp. coffee to 1 c. water.
 - (b) For medium coffee, use 2 tbsp. coffee to 1 c. water.
 - (c) For strong coffee, use 3 tbsp. coffee to 1 c. water.

Here's how to make coffee

A. COLD WATER METHOD

1. Place coffee and cold water on heat.
2. Bring just to the boil.
3. Let stand 6 minutes, over low heat or in warm place.
4. Add 2 tbsp. cold water to settle the grounds.
5. Serve immediately.

B. STEEPED COFFEE METHOD

1. Pour freshly boiling water directly on coffee in heated coffee pot.
2. Allow to stand 6 minutes over low heat or in warm place. Do not boil.
3. Add 2 tbsp. cold water to settle grounds.
4. Serve immediately.

C. PERCOLATOR METHOD

1. Place coffee in coffee basket of percolator.
2. Put boiling water in bottom.
3. Start to time when water comes through jet.
4. Percolate slowly 6 to 10 minutes. Remove coffee basket.
5. Serve immediately.

D. DRIPOLATOR METHOD

1. Place coffee in sieve compartment of dripolator.
2. Pour freshly boiling water in upper container.
3. Allow to drip through the coffee.
4. Serve immediately.

E. VACUUM DRIP METHOD

1. Put filter in place according to manufacturer's directions.
2. Place coffee in top container. Cover.

3. Put freshly drawn water in bottom compartment. Fit the two containers together. Place on heat.
4. When water has risen to the top section, allow container to remain on the heat for 3 minutes. Then remove from the heat until beverage has filtered into the bottom compartment.
5. Serve immediately.

Cocoa

- $\frac{1}{4}$ c.- $\frac{1}{3}$ c. sugar
- 6 tbsp. cocoa
- $\frac{1}{4}$ tsp. salt
- 1 c. water
- 5 c. milk

1. Combine sugar, cocoa and salt.
 2. Add water, bring to boil. Boil 2 minutes, stirring until thickened.
 3. Add milk and heat slowly to just below boiling point.
 4. Keep hot over hot water. Just before serving beat with Dover egg beater until frothy.
 5. May be served with whipped cream.
- Serves 6.

Cocoa Syrup

- $\frac{1}{2}$ c. cocoa
- $1\frac{1}{4}$ c. sugar
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{3}$ c. cold water
- $\frac{2}{3}$ c. boiling water
- 1 tsp. vanilla

1. Combine cocoa, sugar and salt.
2. Stir in cold water, mix to smooth paste.
3. Add boiling water. Boil 3 minutes.
4. Cool, add vanilla and store in covered container in cool place.
5. For chocolate drinks:
use 2 tbsp. syrup per 1 c. milk.
For chocolate sauce:
reheat, add 2 tbsp. butter.
Serve hot.
Makes approximately 1 pt. syrup.

Fruit Syrup

- 6 oranges
- 3 lemons
- 3 pt. boiling water
- 5 lb. sugar
- 1 tbsp. Epsom salts
- 1 oz. tartaric acid
- 2 oz. citric acid

1. Squeeze juice from oranges and lemons.
2. Put orange and lemon peel through food chopper. Add to boiling water. Boil 5 minutes. Remove from heat.
3. Mix sugar with Epsom salts, tartaric and citric acids. Add to water and chopped peel. Stir until dissolved.
4. Add fruit juice. Strain.
5. Add 3 tbsp. syrup per glass of ice water and serve.
Makes approximately $2\frac{1}{2}$ qt. syrup.

Acknowledgements

The co-operation of the following organizations in the preparation of this bulletin has been appreciated:

Borden Company Limited

Canadian Poultry Review

General Foods Limited

makers of Swans Down Cake Flour, Calumet Baking Powder,
Bakers Chocolate, etc.

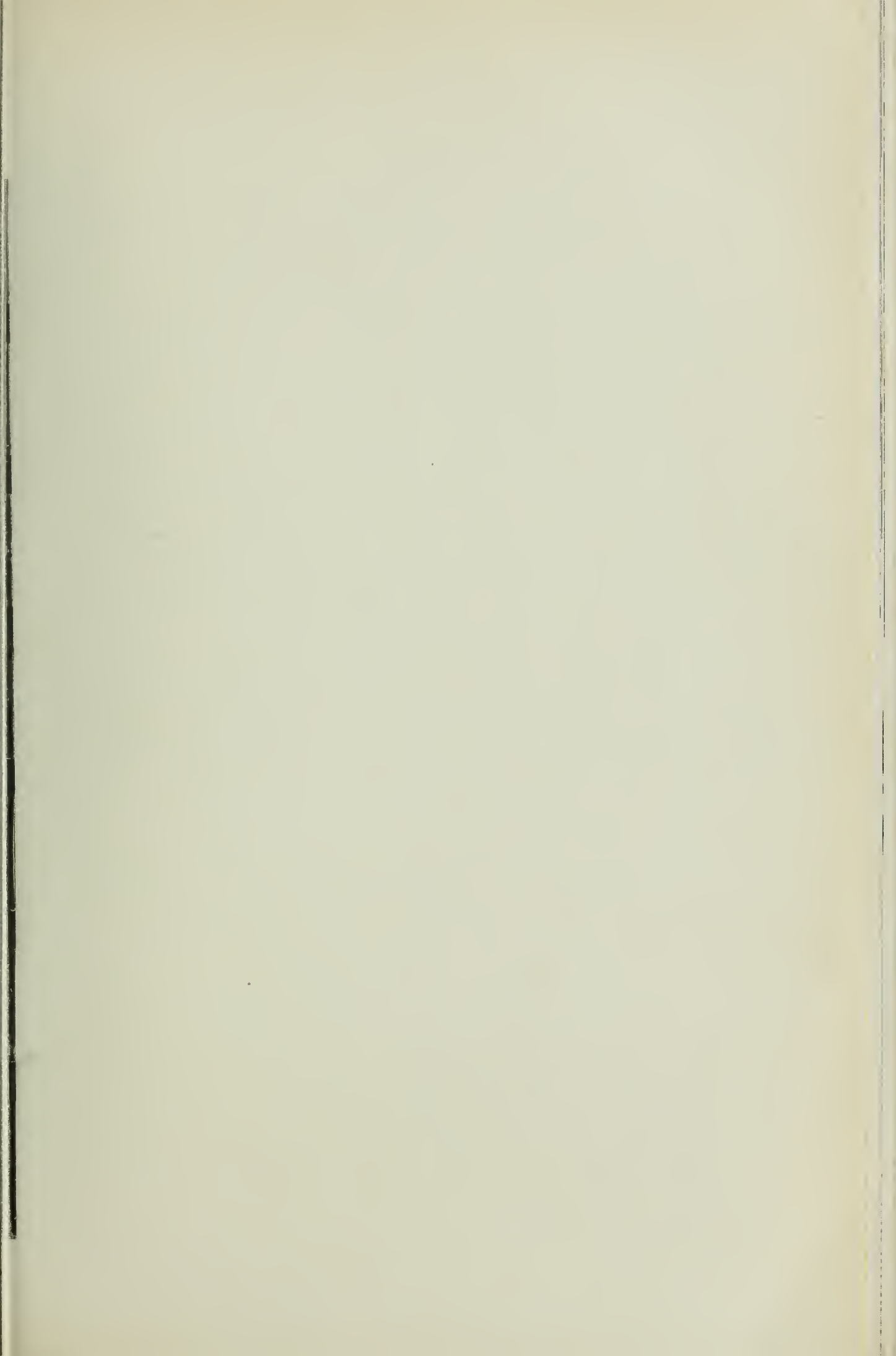
Quaker Oats Company of Canada Limited

Robertshaw Thermostat Company

Swift Canadian Company Limited

Tea Bureau











rev Aug/63

*CARONAF6
B515*



farm ponds

their construction and management

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

farm ponds

their construction and management

by

H. D. AYERS

DEPARTMENT OF AGRICULTURAL ENGINEERING

and

A. DE VOS

DEPARTMENT OF ENTOMOLOGY AND ZOOLOGY

ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO

introduction:

Farm ponds, properly constructed, serve a number of purposes. They may supply water for livestock, domestic use, fire protection, spraying and irrigation. In addition to these uses, they can be a valuable asset for recreation, fish and wildlife production, and beautification.

The traditional sources of water on the farm have been wells or springs. The demand for water at the present time often exceeds the supply from these sources. Electricity on the farm has been responsible for modern water supply and plumbing facilities being provided in rural homes. This has resulted in greatly increased water requirements. The perpetual demand for higher quality produce has made water a necessity for cooling and cleaning purposes. Control of disease, insects, and weeds requires reliable supplies of water for spray purposes. Supplemental irrigation has been demonstrated to be of great benefit for obtaining high yields of top-quality field and garden crops.

Recreation cannot be overlooked as a necessity in rural areas. Fishing, swimming, skating, picnicking, and hunting all provide relaxation and enjoyment and contribute to a fuller life on the farm.

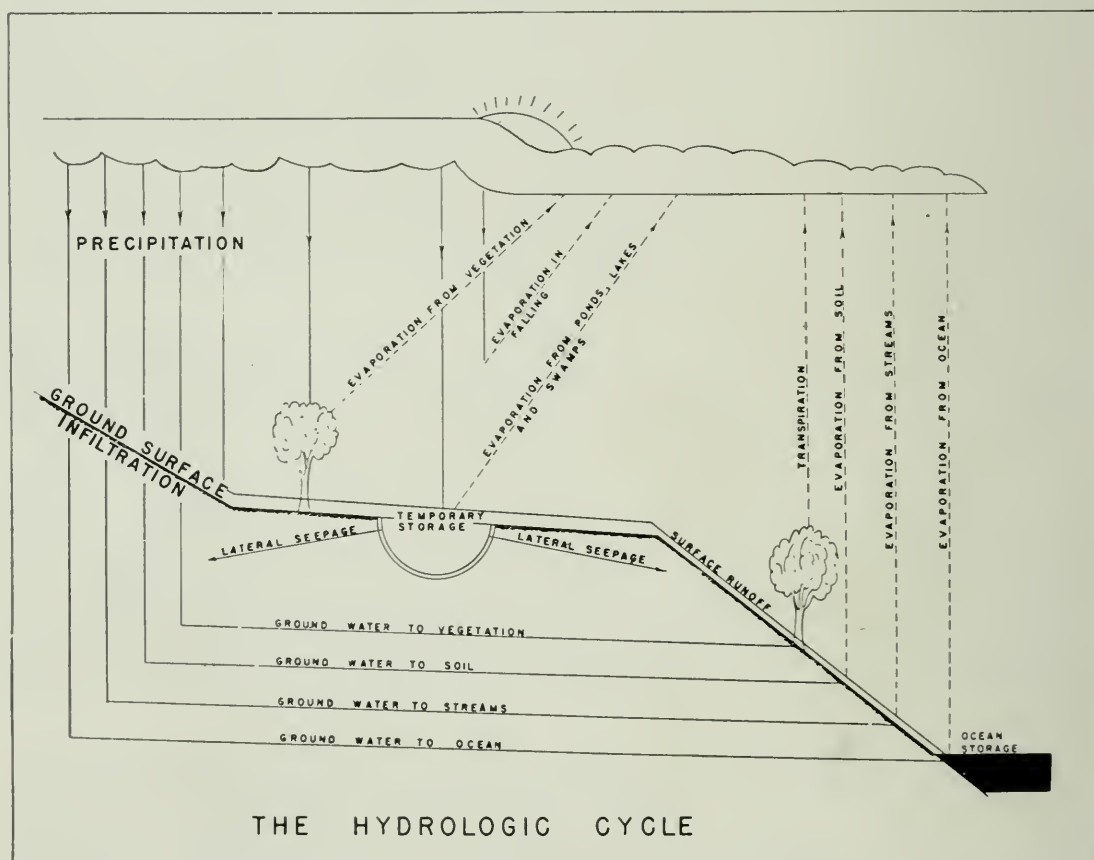
Very minor benefits may be derived from ponds in the form of flood control for urban centres. However, such benefits can only be attained at the expense of depletion of pond storage. To be effective for flood control, a pond must be partially or completely empty. Most owners are unwilling to reduce their storage for this purpose. Similarly, ground water replenishment can only be attained by conditions favourable to a high rate of seepage from ponds.

Ponds cannot possibly control erosion except in the channel or watercourse itself. However, there are generally more effective means for such control. Soil eroded from the contributing watershed will be retained in the pond and will eventually seriously reduce the water storage capacity of the pond, thus proving to be a detriment rather than a benefit.

source of water

The waters of the earth are continuously in circulation. This circulation is called the hydrologic cycle and is illustrated in Fig. 1. The precipitation (rain, snow, sleet, or hail) that falls on the earth's surface is disposed of in a number of ways. Some of it is intercepted by vegetation and evaporated to the atmosphere again. There is also evaporation from the soil surface. Most of the precipitation is absorbed by the soil and used by plants. The excess of the water that enters the soil percolates to the ground water zone. Well water is drawn from this region. Ground water flows laterally and may reappear in the form of springs, seeps, or streams. When the capacity for the soil to absorb water is less than the precipitation rate or rate of snow melt, surface runoff occurs. This flow eventually concentrates in streams and rivers. The flow from springs and streams goes to lakes or larger rivers which flow to the ocean. Evaporation from oceans, inland bodies of water, and vegetation returns water to the atmosphere, where the hydrologic cycle is completed.

Ponds are devices for storing water at some stage of the hydrologic cycle for use at some future date. Ground water or surface runoff water may be stored in ponds. Storage of precipitation on the pond surface contributes a small amount, but this is usually



(Fig. 1)

The circulation of the water of the earth.

counterbalanced by evaporation losses. In this region, surface runoff occurs every year but can be relied upon only during the period of winter or spring snow melt. Occasionally fall rains will result in surface runoff supplies which replenish pond storage. Sufficient storage capacity must be provided to meet all demands and unavoidable losses between periods of recharge.

Ponds constructed to store the water from springs are particularly valuable where the springs dry up for a period in the summer.

Ponds which are supplied from a shallow ground water zone are merely oversized dug wells. Where the conditions are favourable for a large yield of water from the surrounding water-bearing strata, such ponds are well suited to supply irrigation requirements.

Ponds on permanent streams have a reliable supply of water but may be very costly to construct. Except for irrigation, the quantities of water required for farm use are not excessive and do not justify the expense of constructing this type of pond.

Ponds constructed beside streams, drainage ditches, or other watercourses, wherein the water is by-passed from the stream to the pond, will provide a reserve storage of water for peak demands, such as irrigation or fire protection, at a relatively low cost.

selection of the pond site

TYPES OF PONDS

Ponds are often classified according to the source or nature of the water supply. They may be surface runoff, spring-fed, or permanent stream types. However, for purposes of this bulletin, classification will be according to the type of construction involved to obtain storage.

These types are:

1. *Excavated reservoirs*
2. *Impounding reservoirs*

The first mentioned include all those in which storage is provided by excavating below natural ground level. These ponds are often called "dugouts" and can be adapted to almost any topographical condition; they are, however, best suited to relatively flat areas with heavy subsoils. Such ponds may be fed by surface runoff or springs, or through a by-pass from a stream, large natural watercourse, or drainage ditch.

The impounding type of reservoir consists of a dam constructed across a valley or draw, above which water is stored. Favourable topography is essential for this type of pond. Frequently, additional storage is created by excavating below ground level upstream of the dam. Surface runoff and springs are the most suitable water supply for such ponds.



▲ *The impounding type of pond is suitable across natural valley*

▼ *The dugout type of pond is adapted to flat areas.*

Courtesy Conservation Branch, Ontario Department of Planning and Development



soil

The soil is perhaps the most important single factor in determining the suitability of a site and the design of a pond. Light sandy soils permit water to flow through them readily. Ponds constructed on such soils are likely to have excessive seepage losses unless artificial means are adopted to seal them against such losses. Unfortunately many otherwise potentially good pond sites in Ontario have poor subsoil conditions. Fine sand underlies many watercourses or lowlying areas. It has been found that these sands are frequently saturated, in which cases low dams may be satisfactorily constructed if fill material of a heavier texture can be found. Excavated reservoirs are not suitable in dry sands due to the large seepage losses. In saturated sands, the very unstable nature of the soil causes it to flow into the pond from the sides, making it practically impossible to maintain stable banks below the water level. Consequently such ponds require a great deal of maintenance.

topography

The topography or lay of the land will govern the type of pond that will be constructed and, of course, the individual design. As previously pointed out, the excavated pond may be constructed on relatively flat ground where there is a sufficient water supply to fill it or supply the projected needs. This type of pond may be constructed on a river flood plain to be supplied by by-passing part of the water from the main stream. Construction of an excavated pond in a large, relatively flat, and shallow-sodded drainageway has the advantage over the construction of a dam across the drainageway because of the lower cost and reduced flooded area that will result. Constructing such ponds directly on a temporary or permanent stream channel which drains a large area is not recommended since the silt carried in the flood waters will soon fill the pond.

The impounding type of reservoir is suited to a narrow valley or draw with sharply rising banks on either side and a grade of not less than one foot in one hundred feet in the channel itself. Where the channel grade is flat, large areas will be flooded, and there will be much shallow water in which rushes and weeds will thrive. Except for wildlife ponds, this is an undesirable condition. Where the channel grade is too steep, the storage capacity of the pond will be limited. Constructing the dam across the narrowest part of the valley minimizes the length of dam for a given storage and effects a reduction in cost.

proposed uses

For most beneficial use, ponds should be located at or near the point where the water is required. For livestock water, the pond should be centrally located with respect to the grazing area or barns.

Ponds for fire protection should be located close to the farm buildings, while those for spraying or irrigation should be near or within the fields where the water is needed. Recreational ponds or those constructed for fish and wildlife conservation should be built to take advantage of natural surroundings. Waste land may be beautified or made more productive by the construction of a pond within its limits.

Although multiple-use ponds have many advantages, there are certain limitations to their application.

A small pond of one acre or less in size, supplied by surface runoff water only, has little value for fish production or as a wildlife habitat.

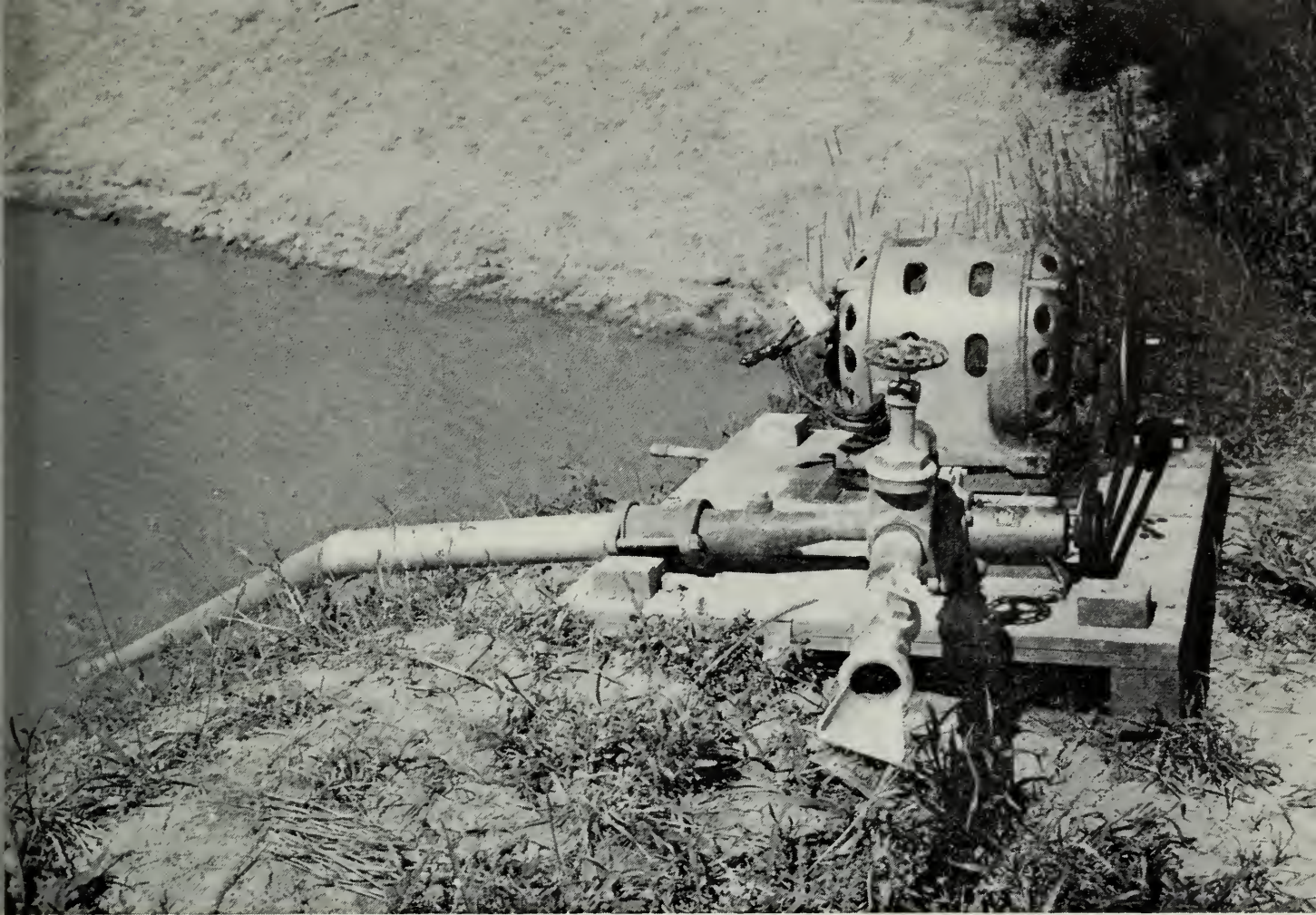
A pond from one acre to five acres in size, however, may be used for either fish or wildlife and other purposes, such as livestock water, spraying, or fire protection, where the demand is relatively small. It would be rather difficult to manage such a pond successfully for both fish and wildlife because their requirements are quite different.

Large ponds of over five acres in size can generally be used successfully for several purposes. Areas of deep cool water provide suitable conditions for fish, while the shallow areas are a favourable habitat for wildlife. In addition, such large ponds have sufficient storage to provide for uses which do not demand excessive quantities of water, without interfering with the fish or wildlife.

Irrigation demands are large, and the multiple use of ponds intended primarily for irrigation is seldom practical.

Ponds for recreational purposes can provide many hours of pleasant relaxation.





Irrigation requires large volumes of storage unless ponds are replenished by ground water.

water supply

Trout ponds should be supplied directly from springs. The best of such ponds have at least one-half to one mile of spring-fed stream above the pond. The requirements of warm-water fish are not so critical, but a continuous supply of fresh water is desirable. For other uses, the nature of the water supply is immaterial providing there is not undue contamination.

The choice of site should be such that economic storage of the required volume of water will result. The specific demand imposed by each use will govern the suitability of site. Sufficient water must be available for storage, and topographical and soil conditions must be favourable for the economic construction of the reservoir. Under almost all conditions in Ontario, 4 acres of drainage area can be depended upon to provide 100,000 gallons of surface runoff water each year. Construction of impounding reservoirs on drainage areas of more than 40 acres should be avoided. The difficulties in controlling flood flows from large drainage basins make construction costs prohibitive. There are certain unavoidable losses from ponds due to evaporation and seepage. Losses due to the latter cause can be largely reduced by proper site selection with respect to soil.

Specific storage requirements for ponds according to their use with allowance for losses are as follows:

Fire Protection:	75,000 gallons
Spray Water: Orchard —	1 gallon/tree/year of growth/ application
Field Crops —	50 gallons/acre/application
Livestock: Drinking only —	500 gallons/month/animal
Drinking plus sanitation —	1500 gallons/month/animal
Irrigation:	270,000 gallons/irrigated acre
Fish: Trout	} See Section "Management of the Pond for Fish and Wildlife."
Warm-water fish (bass)	

construction of the pond

The factors governing the selection of the pond site will in a large measure also determine the design of the pond and construction methods. Pond design is usually a job for someone experienced in this type of work. However, there are certain principles which are applicable to all ponds.

POND DIMENSIONS

The size of the pond should be sufficient to meet the maximum water demand between periods of dependable natural recharge. The following relationship will be useful in estimating the volume of water stored in a pond or in calculating the dimensions required for a particular demand:

$$\text{Volume (gallons)} = 100,000 Ad$$

where A = pond area in acres, and d = maximum depth of water in feet.

For example, a pond of $\frac{1}{4}$ -acre in area, with a maximum depth of 10 feet, will have a capacity of:

$$\text{Volume} = 100,000 \times \frac{1}{4} \times 10 = 250,000 \text{ gallons}$$

The depth of water in any pond, except in those used for wildlife purposes, should not be less than six feet. For ponds where the depth fluctuates considerably during the season owing to use, the depth should be at least ten or twelve feet or sufficient to maintain at least three feet at the lowest stage. Shallow water encourages excessive evaporation, stagnation, and weed growth. In impounding reservoirs there are frequently large areas of shallow water near the edges. These can be excavated to provide a minimum depth of three feet in all parts of the pond. For wildlife production, such areas of shallow depth are desirable. Shallow water also provides suitable spawning sites for warm-water fish.

TABLE 1

Size and approximate capacity of rectangular excavated ponds with 2:1 side slopes and 4:1 end slopes.

Top Dimensions (Feet)	Depth (Feet)	Capacity	
		Cubic Yards	Imperial Gallons
80 x 60	8	680	114,700
	8	975	164,500
	10	980	165,300
	12	990	167,000
	14	1000	168,700
120 x 60	8	1200	202,300
	10	1290	207,500
	12	1330	224,000
	14	1345	226,000
150 x 60	8	1565	264,000
	10	1675	282,000
	12	1800	304,000
	14	1820	307,000
120 x 80	8	1700	287,000
	10	1850	312,000
	12	1970	332,000
	14	1985	335,000
	16	2000	337,000
140 x 80	8	2130	359,000
	10	2340	394,000
	12	2520	425,000
	14	2550	429,000
	16	2590	436,000
160 x 80	8	2500	421,000
	10	2805	472,000
	12	2970	501,000
	14	3090	521,000
	16	3170	533,000
140 x 100	8	2700	455,000
	10	3075	518,000
	12	3250	548,000
	14	3400	573,000
	16	3470	585,000
180 x 100	8	3750	632,000
	10	4250	716,000
	12	4600	775,000
	14	4875	823,000
	16	5075	856,000
200 x 100	8	4375	737,000
	10	4850	818,000
	12	5375	907,000
	14	5650	953,000
	16	5900	995,000

TABLE 1 (Continued)			
Top Dimensions (Feet)	Depth (Feet)	Cubic Yards	Capacity Imperial Gallons
150 x 150	8	4850	818,000
	10	5375	907,000
	12	5825	982,000
	14	6150	1,037,000
	16	6470	1,090,000
180 x 150	8	5950	1,004,000
	10	6850	1,156,000
	12	7550	1,273,000
	14	8100	1,367,000
	16	8550	1,443,000
200 x 150	8	6750	1,140,000
	10	7000	1,181,000
	12	8630	1,457,000
	14	9340	1,576,000
	16	9800	1,653,000
200 x 200	8	9275	1,564,000
	10	10,800	1,820,000
	12	12,050	2,030,000
	14	13,075	2,200,000
	16	13,950	2,350,000

the spillway

All ponds require a spillway of some sort. The spillway is a device for the safe disposal of excess water. Since the pond will be designed to store sufficient water even during years of very low runoff, it will be expected that there will be a surplus of water during most years.

Spillway design is no problem with the dugout pond since the excess water will merely flood over the adjoining land and drain away to a lower elevation. There is little likelihood of damage occurring to a dugout pond as a result of flood flows.

For dams, spillway design is very important and requires the services of someone with a knowledge of watershed conditions who is experienced in the calculation of probable runoff rates. There are two types of spillways generally employed for dams. The mechanical spillway installed in the earth fill itself is usually in the form of a horizontal section of pipe through the foundation of the dam with a vertical riser section attached to the upstream end. This spillway, sometimes called a trickle tube, carries off the normal low water flow in the watercourse and controls the level of water in the pond.

It is seldom economical to design the mechanical spillway to carry the extreme flood flows. For this reason an emergency spillway is also constructed, of dimensions sufficiently large to carry the greatest flow expected in any 25-year period. This spillway is in the form of a channel excavated in undisturbed earth around the end of the dam, or from the pond to an adjoining watercourse. The grade of the spillway should not exceed one foot in one hundred feet. When such is the case, a good cover of dense grass is quite adequate to control erosion in the channel. Where the grade in the channel



Concrete notch spillway in earth dam.

exceeds one per cent, some other form of mechanical protection, such as masonry or asphalt, will have to be utilized.

In certain cases it is not practical to construct a channel spillway. When the banks on either side of the natural watercourse rise to an elevation much higher than the dam itself, or when there is insufficient space for a satisfactory channel spillway, it becomes very costly to provide this type of protection for the dam. In such cases the entire flow is disposed of through a mechanical spillway in the dam. This spillway may be a concrete structure with an opening, the size of which may be regulated by the use of removable stop logs, or it may consist of one or more large pipes similar to the mechanical spillway previously described.

construction of excavated ponds

Where the soil is dry, the farm tractor with trailed or mounted scoop may be used for excavation. However, this method should not be used unless there is plenty of time available for the job. In spite of the higher hourly cost, the use of a track-type tractor of 30 horsepower or more is justified for the excavation of dugouts. Equipped with bulldozer blades or hauling wheeled scrapers or carryalls, such machines can quickly excavate the earth, spread it around the pond, and leave a neat-appearing job. The speed with which such machines are capable of working soon repays the extra hourly cost of operation.

Where the pond is greater than 60 feet in length, the crawler tractor with wheeled carryall is the most efficient earth mover.

Larger loads may be carried than with a bulldozer, necessitating fewer trips. At the same time, the excess earth may be hauled some distance away to fill low-lying areas or be spread over a larger area surrounding the pond.

Loose earth should not be left near the edge of the pond because subsequent rains will wash soil into the reservoir. The excavated earth should be seeded down to grass after spreading and smoothing operations are complete. Liberal quantities of manure and fertilizer will be required to ensure a vigorous growth. If irrigation equipment is available, it may be used to obtain a good germination when rainfall is deficient.

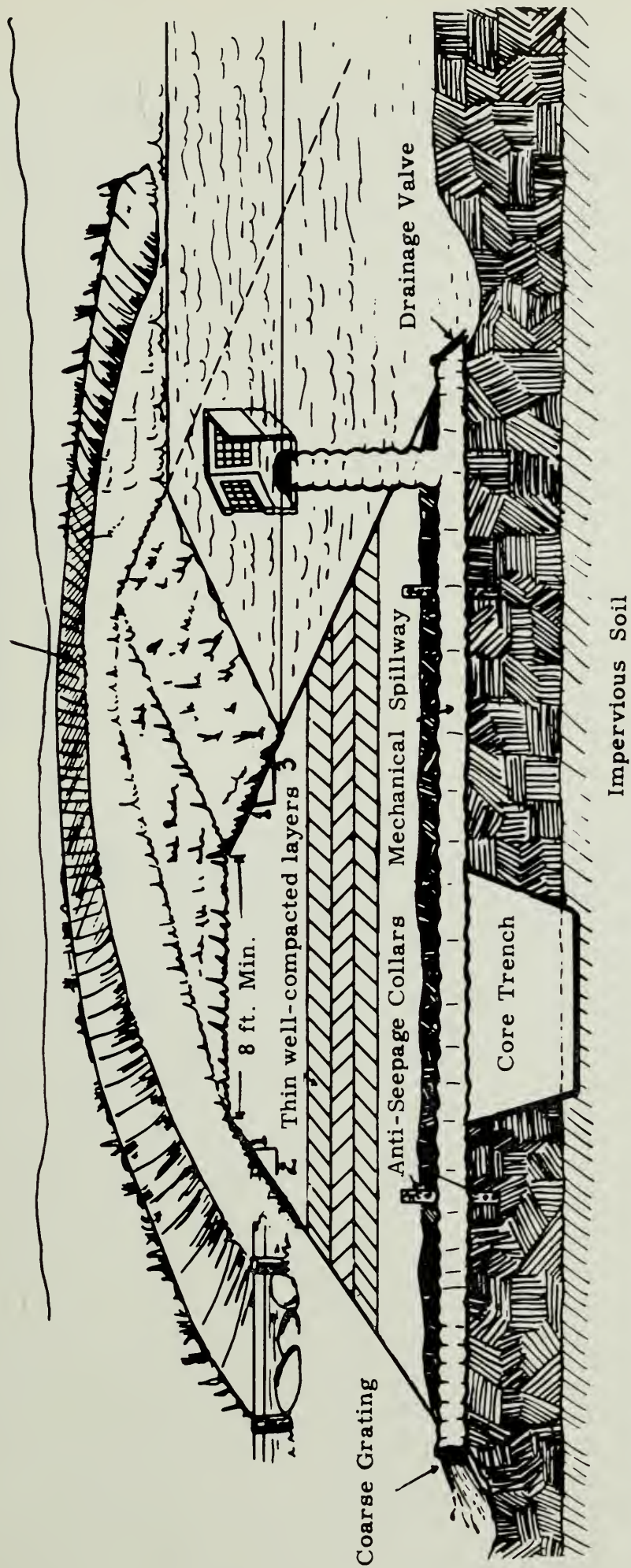
It is very important that the inside banks of the dugout be sloped no steeper than 2:1 (two feet of horizontal distance for each foot of vertical depth). Ponds excavated in sand below the water table should have slopes of 3:1 or 4:1 for stability.

When the soil is wet, as in the case of the pond fed from a shallow-ground water zone, a dragline or some similar machine will be required for excavation. A dragline which has a boom with a cable-operated bucket can operate from firm ground at the edge of the pond site. The boom and cable-operated bucket can be extended over the pond site to excavate to any practical pond depth and surface dimensions.

Using track-type tractor and scraper for the construction of a dugout pond.



Emergency Spillway



Cross-section of dam for impounding reservoir.

the impounding reservoir

The same principles regarding the use of machines apply in the construction of the earth fill for a dam. The essential requirement for an earth dam is that it be stable and retain water behind it with a minimum of seepage loss.

Prevention of seepage through or under the fill is accomplished by the use in the fill of a central core of clay which extends into the dam foundation to an impermeable underlying strata. If such an impermeable strata does not exist at a reasonable depth, the upstream face of the dam and the flooded pond site will have to be covered with a clay blanket.

While pure clay provides an effective barrier to seepage of water as long as it is wet, it develops cracks upon drying, which may permit considerable water losses in reservoirs where the water level fluctuates with the season. A well-graded mixture of sand, silt, and clay, with 20 per cent of the latter, is even more effective than clay as an earth fill material. Such a mixture with a moisture content sufficient to secure compaction can be used throughout the fill and to backfill the core trench, providing it is placed in thin layers and thoroughly compacted.

procedure for the construction of a dam

1. Preparing the site of the dam and borrow pit

All materials such as stumps, brush, sod, and large roots should be removed from the site; the surface should be roughened with corrugations parallel to the main axis of the dam to provide a good bond between the earth fill and the foundation. All trees should be removed from the flooded area of the pond site.

2. Construction of the core trench

The trench should be dug in the foundation along the main axis and extending the full length of the dam. The trench should be of a width which can be conveniently excavated by machine and deep enough to penetrate material less permeable than that immediately underlying the dam.

The trench is then backfilled with a soil which, when moistened and compacted, will result in a dense impermeable barrier. The soil should be placed in layers of not more than six inches in depth. Compaction may be attained by the wheels of a rubber-tired tractor or similar equipment.

3. Mechanical spillway

The trickle tube should be of cast iron or corrugated steel, asbestos-bonded and asphalt-coated, and installed in a graded trench before any fill is placed. At least two anti-seepage collars of steel plate or concrete should be placed at the one-third points of the pipe. The tube and collars are then backfilled with moist clay and thoroughly compacted.

A drain plug or valve should be installed on the upstream end of the trickle tube to permit drainage of the pond or control of the water level.

The vertical riser portion of the tube should be welded to the horizontal section or attached by means of a fabricated tee. The joint should be made watertight and the tube backfilled with clay and tamped by hand. A coarse screen should be placed over the open end of the riser section to exclude trash and animals from the tube.

4. *Emergency spillway*

An emergency spillway is constructed in the manner specified in the design. If the spillway is to be a channel type, it should be excavated in undisturbed earth, with the inlet end and outlet end at least 25 per cent wider than the main spillway channel. The sides of the channel should be sloped no steeper than 2:1. The bed of the channel should be level in a direction perpendicular to the direction of flow.

A protective covering of sod or other materials should be provided at the earliest opportunity after construction.

5. *Pipe for stock watering*

A pipe from the intake to the watering troughs should be installed before any fill is placed. The pipe should be 1 $\frac{1}{4}$ inches in

Mechanical spillway riser pipe with screened inlet.

Photograph courtesy A. H. Berst.





▲ *Concrete spillway in need of maintenance. Erosion has resulted in considerable damage.*

▼ *Failure of a farm pond due to insufficient spillway capacity. The flood was result of Hurricane Hazel, October 1954.*



diameter, installed in the same manner as the trickle tube, and should include anti-seepage collars.

A filter should be constructed at the inlet end to prevent dirt and small fish from being carried into the pipe. One satisfactory method consists of attaching a three-foot section of pipe upright at the inlet end. About thirty $\frac{1}{4}$ -inch holes should be drilled in this upright section. A 40-gallon barrel with slots cut in the side and placed over the upright pipe, then filled with coarse gravel, will complete the filter.

6. *Construction of the fill*

Fill materials should not contain an appreciable concentration of vegetation, large rocks, frozen soil, or other foreign substances. Moisture content should be sufficient to secure compaction. When kneaded in the hand, the soil should just form a ball which does not readily separate.

Each layer which should extend over the full width of the dam, should be compacted by the operation of tractors or other earth-moving equipment or by rolling with a flat or sheepsfoot roller. If the moisture content of the fill materials is deficient, water should be sprinkled after compaction and before the next layer is placed.

Fill must not be placed on frozen soil. An extra ten per cent should be added to the fill height to allow for settlement.

7. *Slopes*

Fill slopes should not be steeper than 3:1 on the upstream side and 2:1 on the downstream side. Portions of slopes not submerged in water should be seeded down to a shallow-rooted grass to provide protection.

8. *Width of the top of dam*

The minimum top width should be eight feet. When the top of the dam is to be used as a farm roadway, the top width should not be less than twelve feet.

management

of the pond for fish and wildlife

The pond should be fenced to keep livestock from tramping near the edges. Where small children live near the pond, extra precautions must be taken for their safety.

Trees should not be planted on a dam. Normally it is not advisable to have tall trees close to the edge of a pond because of the accumulation of leaves in the water. However, if one wants to encourage the nesting of wood ducks, the proximity of trees to water is essential.

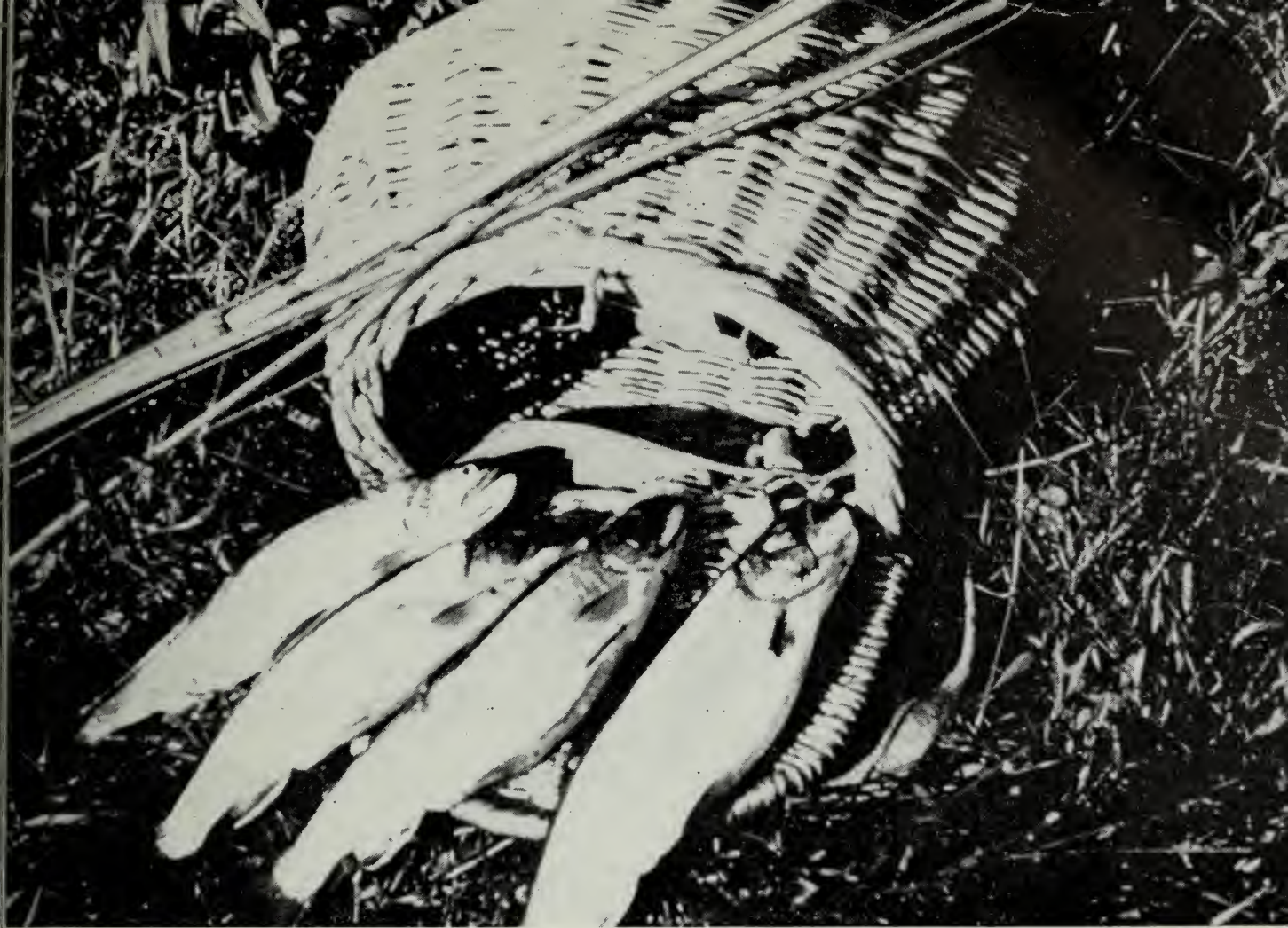
Dams and spillways should be inspected periodically for damage from erosion or burrowing animals. A proper clay core of about 15 feet at the base generally prevents complete failure of the dam due to the burrowing of muskrats. Appropriate repairs or preventive action should be taken as soon as such damage is discovered. Failure to do this may result in complete destruction of the dam or spillway.

Weed and aquatic growth in the pond can be reduced by maintaining a minimum depth of six feet of water. Algae can be controlled by repeated doses of copper sulphate or bluestone at one pound per 100,000 gallons of water. Turbid or cloudy pond water can be controlled by scattering 200 pounds of agricultural gypsum over the pond surface for each 100,000 gallons of water or 50 pounds of commercial aluminum sulphate per 100,000 gallons of water.

Silt accumulation in farm ponds can be avoided by protection of the watershed against erosion. Maintaining a reasonable amount of protection for the soil in the form of hay or pasture crops and practising conservation methods will reduce soil losses and maintain a silt-free pond indefinitely.

trout ponds

Trout ponds should be spring-fed and a minimum of $\frac{1}{4}$ -acre in size with an average depth of at least 5 feet to 6 feet, with some parts being at least 10 feet deep. A good circulation of water is desirable but, if possible, the outlet should be screened. Pond temperatures at the surface can be as high as 80° F. without causing any great harm, but bottom temperatures should never exceed 70° F. and preferably they should average 60° F. or slightly less in mid-summer. Some leafy vegetation in the pond is desirable for cover and food production, but for the best results no more than about 20 per cent of the bottom should be covered.



A catch of speckled trout from a farm pond near Aylmer, Ontario.

Photograph courtesy A. H. Berst.

Stocking and management

The speckled trout is the most popular species for ponds. These trout may be purchased from private hatcheries which operate under permits from the Department of Lands and Forests.

In average ponds, 400 to 500 yearlings or 800 to 1000 fingerlings may be stocked per surface acre of water. Yearlings stocked in the fall should be of catchable size the following summer. Yearlings stocked in the spring should be catchable size by the fall of the same year. Generally speaking, no other species should be stocked in a pond suitable for trout. Natural reproduction of trout in ponds can generally be discounted. Consequently, the pond owner must be prepared to re-introduce yearling or fingerling fish as the stock becomes depleted.

Kamloops trout is an excellent species for the larger ponds. They can be mixed safely with speckled trout and can withstand warmer water temperatures. Brown trout do not make good pond fish as they are very difficult to catch. It is unwise to mix brown trout and speckled trout.

The introduction of plants and/or fertilizer is neither necessary nor advisable in most trout ponds.

warm-water fish ponds

1. *For food and sport fish*

The size of the pond is important. An acre or two of water is necessary to provide fishing for a family and friends. A pond of less than half an acre is hardly worth stocking. Either by-pass or direct water supply is satisfactory, but ponds which depend entirely on run-off tend towards over-supply in spring, stagnation in August, and heavy mortality in winter.

There are no private hatcheries for warm-water fish in Ontario. Fingerling stock can be seined and transported, under supervision of a Department of Lands and Forests officer, from another pond with the consent of the owner. If your pond is large enough and fully open to the public, application should be made to the Department of Lands and Forests for suitable stock. Largemouth bass and bluegills are distributed usually in the period from July to September.

Largemouth bass and bluegills or largemouth bass and golden shiners are widely used combinations. Introduction of a third species such as bullheads or crappies in conjunction with either of the above complicates management and seldom improves fishing. The latter species should be stocked by themselves. If the pond already contains combinations of carp, bullheads, crappies, perch, golden shiners, or chubs, it is best to drain the pond, poison* the fish population, and re-stock with suitable species.

Stocking rates vary according to size and condition of the pond. Recommended stocking rates per acre are as follows:

Largemouth Bass	Bluegills	Largemouth Bass	Golden Shiners
50 fingerlings	10 adults or 500 fingerlings	50 fingerlings	24 adults

Under normal conditions in Ontario, the bluegills should be a catchable size the year after stocking. The largemouth bass should be of legal size (11" total length in Ontario) two to four years after stocking.

The spawning season for bass and bluegills in south-western Ontario is in May or June, depending on temperatures. Bluegills spawn slightly later than bass and may spawn several times during the summer, whereas bass spawn only once a season. Both species lay their eggs in nests, which are circular depressions on the pond bottom in two feet to five feet of water. The male parent guards the nest against intruders until some time after the eggs are hatched. If the water is clear enough, this nesting process can be readily observed from the shore.

*All poisoning must be done under authority and supervision of Department of Lands and Forests officers.

The aim in the proper management of a pond for maximum returns in fish production should be to maintain a proper balance between the bass (the predator species) and bluegills or shiners (the main food of bass in the pond). A great deal of fishing is necessary to achieve this. Bluegills reproduce faster than bass, and it is necessary to fish much harder for them to prevent overpopulation. They should be fished for immediately after they have spawned once, and every bluegill caught should be kept, regardless of size. Fishing for bass should start soon after the first broods of young bass appear which, in southern Ontario, probably will be one or two years after the bluegills spawn for the first time. Don't be discouraged if there are fluctuations in the quality of the fishing. This occurs in all waters. It is caused by factors such as changes in temperature and food supply. If stunting occurs in bluegills (and this often happens) then you are not fishing hard enough for them; it may even be necessary to drain the pond in part and remove excess bluegills with a minnow seine. Also too many bluegills will seriously curtail reproduction of the bass, since hungry bluegills eat bass eggs and fry.

The use of fertilizer as a means of increasing fish production must be approached with caution. While good results are sometimes obtained by the use of fertilizer, it often has the reverse effect. A good rule of thumb is to leave well enough alone unless the need for fertilizer is obvious, and even then one should apply it following the recommendations of a competent biologist who has made a thorough assessment of the requirements.

2. *Minnow ponds*

Ponds of this class are usually too warm for trout and too small for angling of warm-water species. One manner or method in which this type of pond can be utilized is the rearing of minnows for profit. The sale of minnows can result in a net profit in excess of many agricultural crops on an acreage basis. The first step, of course, is to investigate the market. Once the demand for bait minnows is assured, a thorough search of all literature available on the subject should be made. The rearing of minnows in sufficient quantities to make it worth while is not a simple matter. However, this should not deter anyone with ponds available from investigating the possibilities. While the subject is not too difficult, it is detailed and much too lengthy for this bulletin to attempt. An expert on this subject should be consulted before one embarks upon such a venture.

farm ponds and wildlife

The value of farm ponds to wildlife may be considered from two points of view: first, wildlife that may use the pond itself; and secondly, wildlife that is attracted to the pond surroundings.

The pond itself, if it is to be of value as a habitat for wildlife, must be permitted, at least in part, to grow up to emergent water plants. Without such growth, ducks, other marsh birds, and muskrats will find insufficient food and cover. It is therefore desirable

that at least half of the pond acreage has a water depth of *not more* than three feet. For muskrat and fish survival during the winter, it is essential to have *one* or more deeper sections in the pond which do not freeze to the bottom, even in severe winters.

Some aquatic plants, particularly cattails, may tend to spread too freely, choking out more valuable species. Muskrats will help to control this, as they use the cattail extensively for food and in making their houses. Their activities in helping to keep the vegetation more open make the habitat more favourable for ducks.

Ducks and other marsh birds, while making little direct use of cattails for food, will use it for nesting cover and for shelter of young broods.

The ducks which are most commonly found around farm ponds in Ontario are Mallard, Black Duck, and Blue-winged Teal. Even a very small pond may produce a brood of ducks if there is good nesting cover available.

Besides muskrats, mink and raccoon are attracted to ponds, largely because of a readily available food supply.

Unless the pond is well protected by the topography, a wind-break should be provided on the north and west. A double row of spruce or white cedar is the most effective. In addition to attracting wildlife, it will reduce wave action and shore erosion around the pond.

Clumps of shrubs such as dogwood, nannyberry, wild raisin, chokecherry, and elderberry provide both cover and food in the form of fruit. In the wettest places, high-bush cranberry and black alder (or winterberry) are berry-producing shrubs for wildlife. The balance of the area may be left in grass, legumes, and herbaceous vegetation to provide nesting sites for ducks and pheasants. If sufficient area is available, additional small dense clumps of conifers will provide good winter shelter for pheasants and rabbits. If the soil is sandy, pines and red cedar will thrive better than white cedar and spruce.

The provision of a variety of cover — conifers, shrubs, and areas of grass and legumes — will attract the greatest variety of wildlife. This is true both of game species, furbearers, and the smaller insect- and seed-eating birds.

The pond area will be more valuable and attractive if it can be connected with outlying parts of the farm by shrubbery fence lines. These will provide sheltered travel lanes for wildlife travelling to and from the pond.

The provision of nesting boxes for such birds as tree swallows and bluebirds will help to increase the population of these attractive insect-eating species.

legal aspects of water use

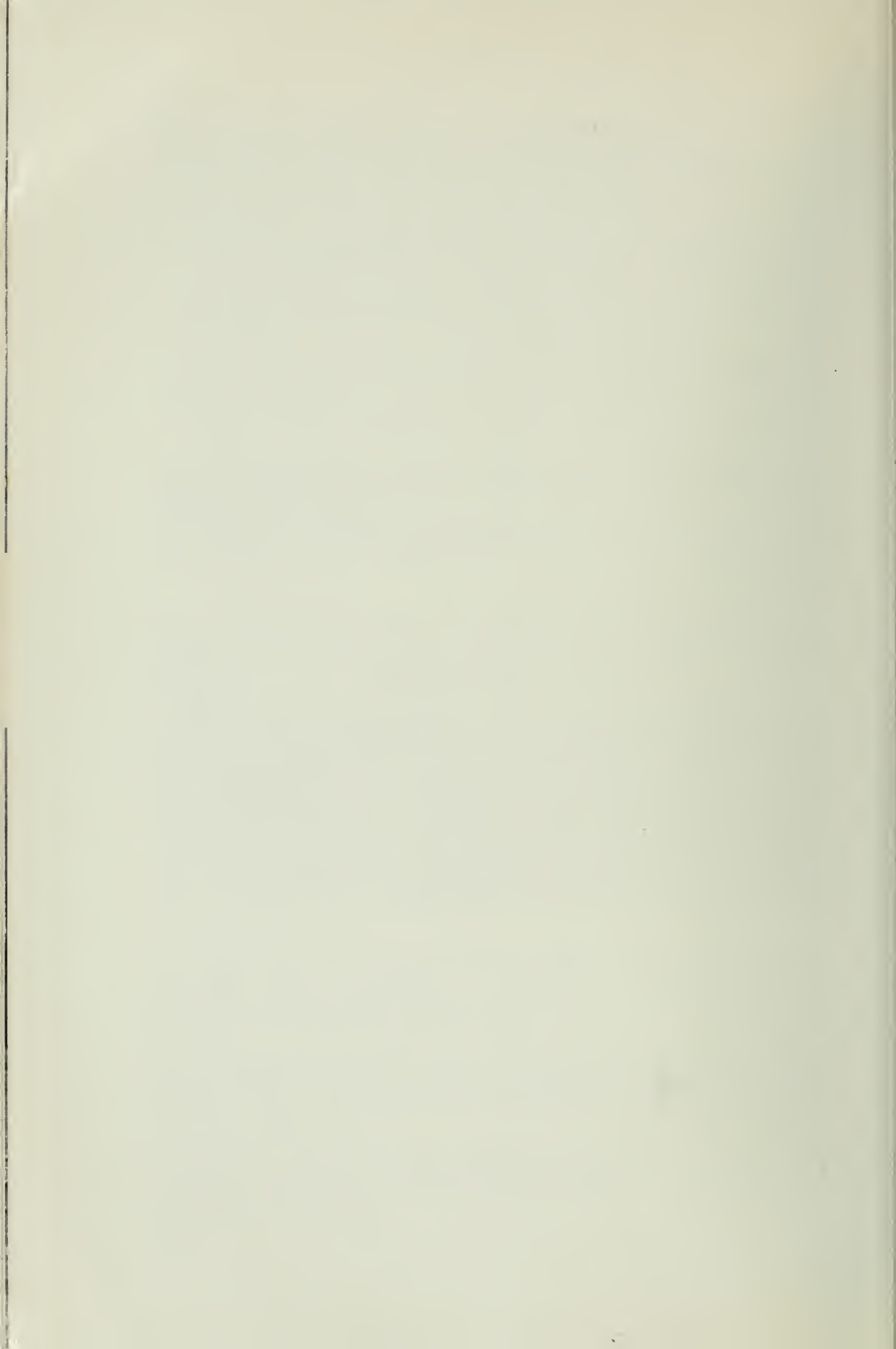
At the present time there are no Provincial statutes governing the use of surface water supplies. However, since much of our legal structure is derived from English common law, the "riparian doctrine" would be the basis for any legal decision involving water rights. A riparian owner is one who owns land that abuts on water and who has, as an incident to his property in the riparian land, a proprietary right to have water flow to him in its natural state in flow, quantity, and quality, neither increased nor diminished. The right to a reasonable use for livestock or domestic purposes has seldom been questioned. Irrigation, on the other hand, requires considerably greater volumes of water and may in time lead to disputes over water rights. Users of water for such purposes should take action to protect their prior right by registering by date a claim for the use of water.

Approval for the construction of dams on permanent streams must be obtained from the Minister of Lands and Forests, Province of Ontario. The requirements for such construction are outlined in the "Lakes and Rivers Improvement Act, Revised Statutes of Ontario, 1950".

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of Mr. A. H. Berst, Mr. J. F. Gage, Dr. H. R. McCrimmon, and Mr. R. D. Usher, biologists of the Department of Lands and Forests, who made information available for the section on "Management of the Pond for Fish and Wildlife". The assistance and suggestions submitted by Professor Downing and other members of the Department of Agricultural Engineering, Ontario Agricultural College, are greatly appreciated. The manuscript was reviewed by Dr. Harkness of the Department of Lands and Forests, and his encouragement of the preparation of this bulletin is appreciated.

•



CA26NAF6
B516

GROWING WINTER WHEAT IN ONTARIO

•

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO



ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

•



GROWING WINTER WHEAT IN ONTARIO

by W. H. Waddell

*Department of Field Husbandry,
Ontario Agricultural College, Guelph, Ontario*

The main winter wheat area of Ontario extends south-westward from a line drawn roughly from Midland to Kingston. Red wheats are grown to some extent in Kent and Essex counties. Elsewhere in the Province white wheats predominate.

An area of high production is found north and west of London in the counties of Lambton, Kent, Essex, and Middlesex. North of Toronto there is another area of high production in the counties of York and Simcoe. In each of these six counties over a million bushels of winter wheat are produced annually. About half of the winter wheat crop in Ontario is produced in the ten counties listed in the table below.

TABLE I

Production of winter wheat in Ontario showing the ten counties which stood highest for total production for a five-year period, 1951-1955.

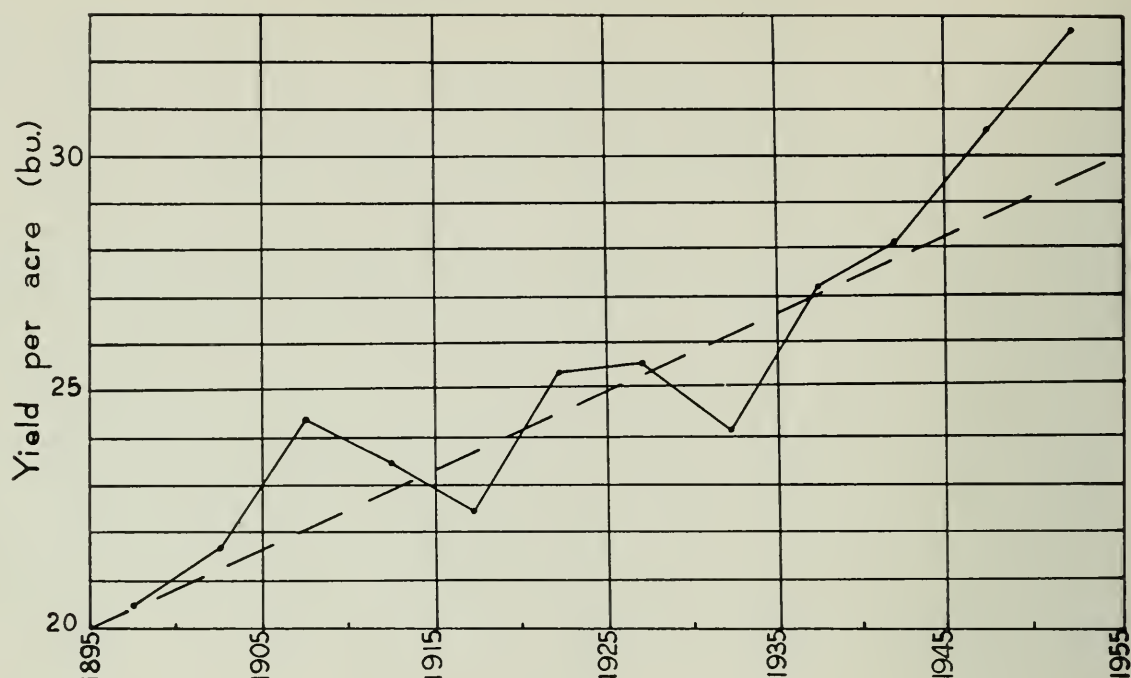
COUNTY	AVERAGE YEARLY PRODUCTION in bushels
Kent	2,456,620
Essex.....	1,511,860
Middlesex.....	1,434,020
Lambton.....	1,420,380
Simcoe.....	1,391,380
York.....	1,194,060
Oxford.....	868,820
Waterloo.....	837,940
Huron.....	773,400
Elgin.....	756,160

Ontario is in a favourable position of producing practically all of the winter wheat used for pastry purposes in Canada. Owing to the mild climate and adequate snow covering, moderately hardy varieties can be grown in the winter wheat area of the Province.

THE IMPORTANCE OF THE CROP

Ontario produces annually about 22,000,000 bushels of winter wheat, or fall wheat, as it is sometimes called. Production has reached an annual figure of 26,000,000 bushels, with a total farm value of about \$40,000,000. The yield per acre has been increasing, the average for the past five years being 32.8 bushels per acre.

The steady increase in yield per acre of winter wheat in Ontario is illustrated in the chart below. The data are for five-year averages.



The broken line would indicate an increase from 20 bushels per acre in 1895 to 30 bushels in 1955, an increase of 50 per cent in yield. It will be noted that the average yield per acre over the past 60 years follows this line fairly closely. There has not been a corresponding increase in oats and barley.

The importance of the winter wheat crop may be judged from Table II, which was compiled from the Monthly Crop Report of the Ontario Department of Agriculture.

TABLE II

Production and value of the eight most important Field Crops in Ontario for a five-year period (1951-55), arranged in order of total value.

Crop	Acres	Yield per Acre (bu.)	Total Production (bu.)	Total Value \$	Value per Acre \$
Hay	3,430,800	1.97+	6,768,200+	95,611,800	27.88
Oats	1,684,400	41.7	70,208,800	54,691,200	32.40
Mixed Grain	1,095,400	44.2	48,021,400	42,506,000	38.82
Winter Wheat	675,400	32.8	22,158,600	34,754,000	51.34
Potatoes	57,700	183.7	10,608,600	16,917,000	298.53
Fodder Corn (green)	268,600	9.96+	2,676,600+	11,419,200	42.44
Husking Corn (shelled)	363,200	58.1	21,714,800	29,780,200	82.19
Barley	171,200	34.5	5,932,600	6,984,800	40.00

+Tons

It will be seen from Table II that winter wheat stands fourth in total value as a field crop in Ontario, being exceeded only by hay, oats, and mixed grain.

The column for value per acre is of particular interest. During this five-year period, winter wheat throughout the Province had a value of \$51.34 per acre. This was exceeded only by potatoes and husking corn. However, when the amount of labour and expense of producing these crops is taken into account, winter wheat will be seen to give extremely good value per acre. This, coupled with the high total value of the crop, indicates that winter wheat is one of the most satisfactory field crops for Ontario.

ADVANTAGES OF WINTER WHEAT ✓

Many farmers prefer to grow winter wheat because it is a cash crop and can usually be sold at a satisfactory price. If, however, the price is too low, it can be fed to good advantage on the farm. Usually about half of the Ontario winter wheat crop is fed on the farm.

An additional advantage of winter wheat lies in the fact that it is sown early in the fall when weather conditions are usually favourable. The seeding of spring grains in Ontario is often delayed owing to unfavourable weather conditions, and in many cases an emergency crop with a lower value than oats or barley has to be sown. Should unfavourable fall seeding conditions for winter wheat occur, spring grains could be sown the following spring without the loss of a crop.

The fact that winter wheat is a fall-sown crop allows the farmer to spread his labour over a longer period and thus avoid, to a great extent, the rush of spring work.

Perhaps one of the main advantages of winter wheat is in connection with soil conservation. Land sown to fall wheat will pass through the winter with an excellent cover, which is very beneficial in avoiding erosion on steep slopes. In this respect, winter wheat is almost as desirable as the forage crops.

WINTER WHEAT vs. BARLEY AND OATS

An inspection of Table II indicates that winter wheat has a higher value per acre than either oats or barley, but a lower total value than oats. However, the number of acres required to produce this larger oat crop was more than double the winter wheat acreage.

The figures for "Av. bushels per acre" in Table III may be somewhat misleading since they might indicate that an acre of land sown to oats or barley would produce more feed than an acre sown to wheat. This is not the case, for two reasons. First, the number of pounds in a bushel varies, being 34, 48, and 60 respectively for oats, barley, and wheat. Second, oats carry a hull of about 27 per cent of the total weight and barley has a hull of

about 11 per cent. These hulls are practically valueless as feed. When the comparative value of field crops is being assessed, therefore, it is necessary to compare the production of feed in pounds per acre. Table III shows such a comparison of the three crops for a five-year period.

TABLE III

Comparison of the production in bushels per acre, pounds per acre, and pounds per acre less hull, of winter wheat, oats, and barley, for a five-year period (1951-1955).

Crop	Av. Bushels per Acre	Av. Pounds per Acre	Av. Pounds per Acre Less Hull
Oats	41.7	1418	1035
Barley	34.5	1656	1474
Winter Wheat	32.8	1968	1968

It will be noted from the above table that on the basis of these data an acre of winter wheat will, on the average, produce almost twice as much feed as an acre of oats.

When yields of winter wheat are being compared with spring grains, it is only fair to note that winter wheat is usually planted on a more favourable part of the farm and may receive more attention as regards cultivation and fertilizers. This may account in some degree for the favourable average yields of winter wheat throughout the Province. In addition, winter wheat is usually followed by barley or oats.

WINTER WHEAT vs. SPRING WHEAT

Spring wheat does not yield well in the winter wheat areas of Ontario. The period between good spring seeding conditions and the excessive heat of summer is short. Consequently, spring wheat is not well enough advanced to escape the heat damage, especially at the time that fertilization of the flower takes place. Excessive heat destroys the pollen, and yields are reduced.

Winter wheat, which has its roots well established in the fall, begins rapid development in early spring and is able to escape most of the heat damage. It is also able to establish deeper roots to withstand drought conditions.

In 1949, rod row plots of spring wheat were planted at the Ontario Agricultural College alongside winter wheat plots which had been sown the previous fall on a farm in Middlesex County. Conditions were so dry at Guelph that the spring wheat test was a complete failure, although winter wheat plots nearby yielded from 35 to 40 bushels per acre. The Middlesex test had reasonably good conditions for growth, but the yield on the average was less than half that of adjacent winter wheat plots, as shown on next page.

TABLE V

Comparison of yields of winter and spring wheat varieties grown side by side in Middlesex County in 1949.

Type of Wheat	No. of Varieties in Test	No. of Replicates	Yield per Acre (bu.)
Winter Wheat	12	5	38.3
Spring Wheat	9	5	18.5

In the eastern part of the Province, spring wheat can be grown quite successfully. In this area it will probably outyield winter wheat on the average, unless very hardy varieties of the latter, such as Rideau or Kharkov, are grown.

FERTILITY REQUIREMENTS OF THE WHEAT PLANT

It is very important to maintain, or in some cases increase, the fertility of the soil in order to continue to grow good crops of winter wheat. However, an increase in fertility may reach a practical limit. The amount of barnyard manure on many farms is much below the quantity desired to increase the soil fertility of the particular farm. Also the ploughing down of an entire "green manure" crop must be limited since the area so treated is removed from production for that year.

Thus a limit of fertility may be reached beyond which the farmer cannot go with his own resources. For further increase he must turn to commercial fertilizers. These fertilizers aid in two ways: (1) directly, by increasing the soil fertility and thus allowing for larger production of crops, and (2) indirectly, in that the larger the crops produced, the greater the amount of plant material available to be turned back into the soil in one form or another.



The wheat plot on the left was fertilized. On the right is an unfertilized plot of the same variety with the first row showing some effect of the fertilizer on the neighbouring plot.

It is impossible to recommend a general type and amount of fertilizer to be used on all winter wheat fields in the Province since requirements vary with the type of soil and amount of fertility already in the soil. It is good practice to have a soil analysis made for the particular field where the wheat is to be sown. Recommendations can then be made as to fertilizer requirements. For recommendations, see Circular 144, "Fertilizers for Cereal, Hay and Pasture Crops", released by the Ontario Department of Agriculture.

WINTER WHEAT AND SOIL EROSION

On steep slopes a cover crop is essential to check soil erosion, which destroys thousands of acres of good farm land every year. Excessive rains may occur during the fall or spring, or even in winter, and the destruction is appalling.

When sloping land is left bare from September to April, there is a great danger of erosion by surface run-off. If the slope is steep, it is advisable to leave such land in hay or pasture, but, eventually, this land must be broken up and reseeded. Winter wheat is an excellent crop to grow during the process of reseeding since it can be sown in September, and by freeze-up a thick mat of roots has formed in the surface of the soil. Because of this mass of roots, winter wheat is almost as effective in preventing erosion as the hay or pasture. The reseeding of the area can be done on the winter wheat in the spring. The area is thus left without a crop for a few weeks only during the time the land is being ploughed and prepared for winter wheat. At this time of year soil erosion is usually at a minimum.



Winter wheat is almost as effective as grasses in controlling soil erosion. Note that the gullies stop abruptly at the line between the ploughed field and the winter wheat field.

An excellent example of the effect of winter wheat in preventing soil erosion was seen in a field near Guelph in the spring of 1950. In September 1949, winter wheat had been sown with the rows following the contour of a steep hill in part of a field. The remainder of the field had been ploughed and cultivated. During January, the weather was extremely mild with rain almost every other day, and erosion was excessive.

By the end of April, deep gullies had been cut through the ploughed part of the field, and these gullies extended right up to the rows of winter wheat, where the erosion stopped abruptly, as shown in the illustration on the previous page.

PREPARATION OF THE SEED BED

The manner in which the seed bed is prepared for winter wheat may have a very great effect on the subsequent yield. In fields which have been ploughed out of sod late in the season and where the land has been poorly worked, large areas of grass will be found, weeds will be plentiful, and timothy heads will appear in the wheat the following year.

If wheat is to follow sod, ploughing should be completed at least one month before seeding time for the area. In the Guelph area this should not be later than the first of August, with seeding the first week in September. During this period, the land should be cultivated thoroughly to destroy weeds, break up matted grass roots, and put the soil in a fine state.

If winter wheat is to follow spring grains or crops such as tobacco, white beans, or soybeans, cultivation should be commenced at the earliest possible moment. In this case, ploughing may not be necessary since double discing or using the one-way disc may be sufficient to prepare a good seed bed.

An ideal seed bed is one in which the top two inches are fine and open to admit air and rain but in which the lower part is firm so that the soil is well packed around the seed. For the proper growth of plants, the soil must contain large amounts of air and water as well as all other elements necessary for growth.

While good cultivation between ploughing and seeding is urged, the danger of overcultivation must be considered. It is well known that when the soil is cultivated and stirred the organic matter in the soil is "burned" up at a rapid rate. However, overcultivation of winter wheat land between ploughing and seeding occurs on a very limited number of farms. In the majority of cases the land is undercultivated.

The supply of moisture in the seed bed at planting time is important. During very dry summers, many fields have been prepared for winter wheat but have not been seeded owing to a very dry seed bed. In some seasons, the only fields containing enough moisture to be seeded were those which had been summerfallowed or broken up at an early date. In both cases the soil was open so that most of the precipitation entered the soil and run-off was at a minimum. Also, when the soil is bare, there is no loss of moisture due to transpiration by plants.

DOES SEED "RUN OUT"?

Many farmers complain that their seed wheat at one time was quite pure, but that it has now "run out" and has become a mixture of different kinds. The question then asked is, "Will good seed run out if grown year after year, and must one change the seed in order to keep it up to standard?"

The answer is that it is possible to grow a variety of winter wheat year after year without allowing it to become impure. Otherwise it would be impossible to secure a new supply of pure seed from any source. It is also true that, on the ordinary farm, pure seed usually does not remain pure when grown year after year.

There are two reasons why pure seed tends to deteriorate: (1) by mechanical mixing with other sources of wheat or other grains, and (2) by the spontaneous appearance of new types in the otherwise pure variety. An outstanding example of the latter is the white chaff which often appears in pure strains of Dawson's Golden Chaff.

Mechanical mixing is difficult to control if custom threshing is done. The only remedy is to clean thoroughly the threshing machine or combine before it goes from field to field or from one farm to another. The latter, of course, should be done in any case to avoid the spread of weed seeds.

Impurities in the wheat due to new types which appear can only be eliminated by carefully removing all off-type heads while the crop is standing in the field. This removal of off-types is called "roguing", and would be a difficult task to do in a large field. However, a small area of about an acre could be set apart for seed and carefully rogued to remove all off-types. Most farmers prefer to improve their seed grain by buying registered seed, which must have a high standard of quality.

THE IMPORTANCE OF GOOD SEED

The success of any grain crop depends to a great extent on the selection of good seed. This is particularly true of winter wheat since it must pass through the winter in the ground and sometimes must suffer severe weather conditions such as alternate freezing and thawing, heaving, and cold dry winds during winter and early spring.

In order to withstand such adverse weather conditions, it is necessary to have a strong stand of wheat in late fall, and this is not possible if poor seed is used. This fact was brought out quite clearly in the spring of 1950, which was extremely hard on the winter wheat crop. Stands of wheat which were poor the succeeding fall, due to late seeding or to poor seed, were almost a complete failure, while many other fields suffered very little damage.

If good seed is not available on the farm, it may be necessary to purchase high quality seed from some convenient source. Three classes of seed might be purchased: (1) Commercial No. 1 seed, (2) Certified Seed, and (3) Registered Seed.



Winter wheat breeding plots at the Ontario Agricultural College. Each stake in the foreground represents ten small plots.

Commercial No. 1 seed is of good quality and may be much superior to the farmer's own seed.

Certified seed is of very high quality and must pass inspection by Government officials both as to the standing field and the seed. All bags of certified seed must be sealed by an inspector. Certified seed may be obtained for those varieties which have not been accepted for registration or of which the supply of registered seed is limited.

Registered seed is the highest quality that can be obtained for general use. The regulations governing the quality of this seed are set by the Canadian Seed Growers' Association. As in the case of Certified seed, it too must pass inspection in the field and as seed but must be of somewhat higher quality than Certified. The final stamp of approval is given by officials of the Canadian Seed Growers' Association.

Should a farmer find it necessary to change his seed, he is strongly advised to secure Registered Seed if it is available. The small additional cost of this seed repays itself many times over in the better stand obtained.

When wheat produced on the farm is to be used for seed, it should be thoroughly cleaned to remove shrunken kernels and weed seeds. This may be done properly on the farm or in a local seed cleaning plant, if one is available in the district. The commercial plant will probably have better facilities for cleaning the grain than the average farm.

RATE OF SEEDING

In general, the practice in Ontario is to sow from $1\frac{3}{4}$ to 2 bushels of winter wheat per acre. Observation of yields over a long period of years indicates that this rate of seeding is satisfactory. In cases where the seed to be sown is limited in quantity, as when a new variety is being introduced, the amount sown per acre might be reduced to as low as one bushel per acre. A farmer in the Guelph area sowed Cornell wheat at the rate of one bushel per acre in the fall of 1946 and harvested a crop of 50 bushels per acre the following year. This seems to indicate that when conditions are right, high yields may be obtained from light sowing. In this particular instance, the land had been summerfallowed. In general, it is recommended that winter wheat should be sown at the rate of at least 7 pecks per acre.

Rates of seeding experiments at the Ontario Agricultural College several years ago indicated that higher rate of seeding was good practice. The results of these experiments are shown in the Table below:

TABLE VI

Rate of Seeding Experiment on Winter Wheat for a seven-year period

Rate per Acre (pecks)	Height of Crop (inches)	Percentage Lodged	Wt. per Meas. (bu.)	Yield per Acre	
				Straw (tons)	Grain (bu.)
7	42.8	12.0	61.3	2.53	51.2
6	42.3	9.9	61.2	2.47	50.2
5	41.8	6.4	61.5	2.32	47.7

While, in general, the higher rates of seeding are recommended, it should be noted that this higher rate requires more seed and perhaps causes more lodging than the lower rate.

DATE OF SEEDING

The date of seeding of winter wheat is very important and varies greatly with the locality, insect-free date, and the preceding crop.

In the Guelph area, winter wheat should be seeded during the first week in September in order to get sufficient "top" to bring it safely through the winter. Later seeded wheat will have a smaller "top," and, which is still more important, a small root system. The winter survival of the crop may depend on the extent of development during the preceding fall. An extensive root system insures not only better winter survival but also a higher yield from the plants that do survive. A poorly developed wheat plant that has scarcely survived the winter will not be expected to make a rapid growth and produce a high yield of grain.

Date of seeding experiments were carried out at the Ontario Agricultural College for a seven-year period. Results indicated that good yields of grain were obtained when winter wheat was sown during the period August 26th to September 16th, with slightly better yields from the early September sowing. Better results were also obtained from this seeding in respect to date of maturity, rust reaction, lodging, weight per measured bushel, and yield of straw. A summary of the results of these dates of seeding experiments are given in Table VII.

TABLE VII

Date of Seeding Results on Winter Wheat for a Seven-year Period

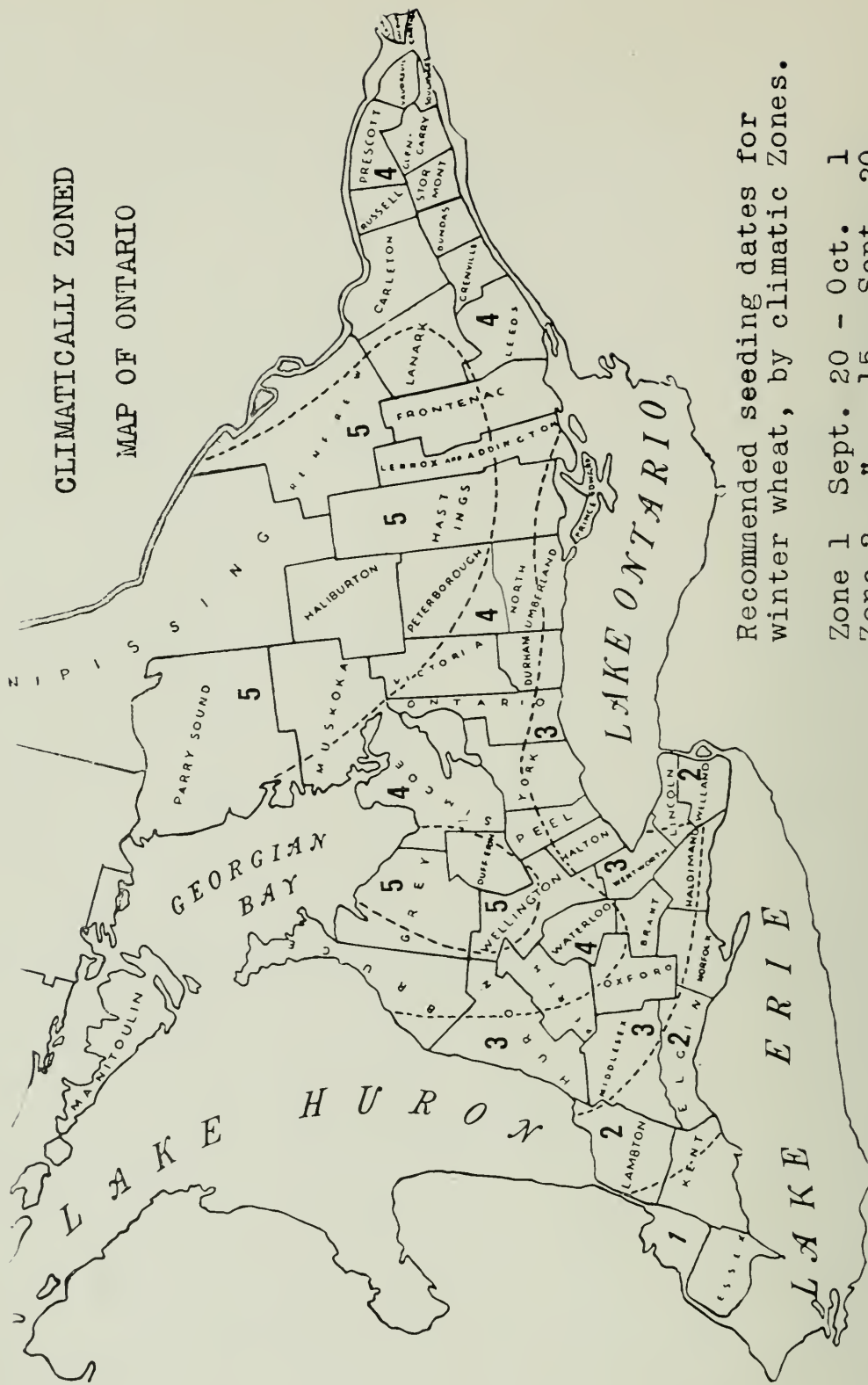
Dates of Seeding	Dates of Maturity	Height of Crop	Percentage Rust	Percentage Lodged	Wt. per Meas. (bu.)	Yield per Acre	
						Straw (tons)	Grain (bu.)
Aug. 26	July 24	45	3	11	61.9	2.8	57.8
Sept. 2	July 24	45	3	17	61.6	3.0	58.9
Sept. 9	July 25	44	4	16	61.5	2.9	57.9
Sept. 16	July 25	44	5	10	61.5	2.7	57.8
Sept. 23	July 27	43	5	12	61.3	2.5	51.8
Sept. 30	July 29	41	8	8	60.6	2.0	40.6
Oct. 7	Aug. 2	40	11	9	58.8	1.8	31.4
Oct. 14	Aug. 7	38	13	7	56.0	1.4	22.3
Oct. 21	Aug. 9	37	14	8	54.1	1.2	16.6
Oct. 29	Aug. 10	37	14	8	53.8	1.0	12.7
Nov. 5	Aug. 10	36	14	7	53.5	1.0	11.9

The above data were taken from Bulletin 332 of the Ontario Agricultural College: "Forty Years' Experiments with Grain Crops" by Dr. C. H. Zavitz.

While early seeding of winter wheat has been recommended, very early seeding should be avoided for two reasons. On fertile soil, with proper weather conditions, a very heavy "top" may develop in the fall, and this may cause smothering under heavy snowfall. Also, early sown fall wheat may be attacked by Hessian fly. Although little damage had been caused by this insect for a long period of years, a rather severe outbreak occurred in Kent County in 1950. This was followed by a very severe outbreak in 1951, particularly in the counties of Halton, Haldimand, and Peel.

It will be seen from Table VII that poorer results were obtained from the Aug. 26th seeding than from the Sept. 2nd seeding. It is possible that fly damage coupled with smothering due to too much top overcame any advantage of the earlier seeding.

The type of crop preceding winter wheat may determine the time of seeding. If wheat is to follow sod and this sod has been ploughed early,



CLIMATICALLY ZONED

MAP OF ONTARIO

Recommended seeding dates for
winter wheat, by climatic Zones.

Zone 1	Sept. 20	-	Oct. 1
Zone 2	"	15	- Sept. 20
Zone 3	"	7	- " 15
Zone 4	"	1	- " 7
Zone 5	Aug. 25	-	- " 1

then the wheat can be sown early. When wheat follows white beans, soybeans, or corn, seeding is often delayed, and a poor crop may result.

The area in which the winter wheat crop is located determines to a great extent the date of seeding of the crop. The five climatic zones of Southern Ontario are shown on the map on page 14. At the right of this map is shown the recommended dates of seeding of winter wheat for each zone. During years when Hessian fly damage has been severe, later dates of seeding are recommended.

WINTER WHEAT TYPES AND VARIETIES

Two types of wheat have been grown in Ontario in the past: soft white winter wheat and moderately strong red winter wheat. In the past, red wheats were grown extensively in the western part of the Province in Kent, Essex, and Lambton counties. Since the two high-yielding white wheats — Cornell 595 and Genesee — were introduced, there has been a sharp decline in the amount of red wheats grown. The red wheats are more resistant to rust and sprouting but give poorer yields than the white wheats.

The most popular winter wheat variety in Ontario for almost 70 years had been Dawson's Golden Chaff. This variety originated as a single plant selection on the farm of Mr. Robert Dawson of Paris, Ontario, in 1881. It was found in a field of Clawson wheat, which was badly lodged, and appeared to have exceptionally stiff straw. The seed from this outstanding plant was carefully saved and planted and eventually became the foundation seed of Ontario's most popular wheat variety, which is now generally known by the shorter name, Dawson's.

The Dawson's variety has been tested for nearly 70 years and has been satisfactory for yield, strength of straw, and the production of pastry flour. However, it is susceptible to all of the common diseases of wheat.

In 1946 a new variety, Cornell 595, was introduced from New York State. It is a white wheat and quite similar to Dawson's, but outyields the older variety by from two to three bushels per acre, has somewhat better pastry quality, and is resistant to loose smut. This variety has been very popular, and it is estimated that at times over half of the acreage of winter wheat in Ontario has been Cornell 595. However, this variety is losing much of its popularity since it shatters badly and is subject to sprouting.

Dawbul, another white-seeded wheat, was produced at the Ontario Agricultural College and was licensed in 1948. It yields about the same as Cornell 595 but is gaining in popularity owing to its resistance to shattering and sprouting. It is resistant to loose smut.

A winter wheat that is becoming quite popular in Ontario is Genesee. Like Cornell 595, it was produced in New York State and was licensed in

Canada in 1952. This variety will probably outyield Cornell 595 by two bushels per acre. It is resistant to loose smut and appears to shatter less than Cornell 595. It may not have quite as strong straw as the latter variety.

All of the above mentioned varieties are quite satisfactory for the production of pastry flour.

Rideau, a soft white wheat, was developed at the Central Experimental Farm, Ottawa. It is definitely more winter hardy than the other white wheats but it is not so satisfactory for milling into pastry flour. It is recommended for the eastern part of the Province only.

Another white wheat, Richmond, has recently been developed at the Central Experimental Farm, Ottawa. It is susceptible to loose smut but has considerable resistance to bunt. Richmond has been an exceptionally high yielding wheat in experimental plots and has satisfactory quality.

The red wheats which have been available up to the present have not been entirely satisfactory. Fairfield was introduced from Indiana and licensed in 1950 but never became very popular, even in the so-called winter wheat area of Ontario. Thorne, an Ohio variety, has been grown to some extent in Kent county and, upon the application of a group of growers, was licensed in 1952. Two or three red-seeded hybrids under test at the present time appear to have considerable promise.

DWARF BUNT

A new soil-borne disease called dwarf bunt has appeared in Ontario. While this disease may have been present for some years, the first specimen to be



A small plot of winter wheat with more than half the heads affected with dwarf bunt.

identified as dwarf bunt was found by a member of the Department of Botany of the Ontario Agricultural College in a field of winter wheat in York county during the late summer of 1952.

Dwarf bunt is, in many respects, similar to the ordinary bunt disease, but the wheat plant is stunted and usually is less than half as tall as the normal plant. The ripened head of wheat affected with dwarf bunt is usually slightly curved, and all the kernels are replaced by bunt balls.

The tiny spores of dwarf bunt differ from those of common bunt in that the dwarf bunt spores under the microscope are seen to be surrounded by a semi-transparent ring and to have a spiny surface.

Up to the present the loss in winter wheat due to dwarf bunt has been slight, in most cases less than one per cent of the plants in the field being affected. In one field in the north of Simcoe county, the loss in 1955 was estimated at 25 per cent. Much higher percentages of the disease have been found in experimental plots in Bruce county, where a heavy load of spores was added to infested soil. The heaviest loss has been to the grower of pure seed because a slight trace of dwarf bunt in his field will prevent him from obtaining registration on his crop.

At present there seems to be no satisfactory control for dwarf bunt. Certain seed treatments have been recommended, and these treatments will prevent the germination of dwarf bunt spores carried on the seed. However, since spores may live in the soil for two or more years, clean seed placed in the ground may produce a crop that carries a large percentage of dwarf bunt.

A farmer whose land is apparently free of dwarf bunt should be particularly careful to see that nothing but clean seed is sown. In addition he should take care that custom machinery does not bring the disease on to his farm.

In the state of Washington, where the disease has been quite prevalent for many years, the loss due to dwarf bunt has been almost eliminated by growing varieties that are resistant to the disease. These varieties are not suitable for growing in Ontario.

The major objective of the plant breeding project in winter wheat in Ontario at present is the production of varieties resistant to dwarf bunt. For further particulars on this disease see Circular 183, "Stop Dwarf Bunt", released by the Ontario Department of Agriculture.

SUMMARY OF DISEASES ON WINTER WHEAT

In tabular form on the next page is given a summary of the main diseases found in winter wheat and the control measures, where possible.

DISEASES OF WINTER WHEAT

Disease	Infection		Control
	Time	Manner	
Loose Smut	At heading time.	Spores enter open flower.	Hot water treatment, resistant varieties.
Bunt	After seed is sown.	Spores get on seed at threshing time, germinate when sown.	Mercuric and organic compounds.
Leaf Rust	Mid to late June.	Air-borne spores light on plant, germinate, and germ tubes enter stomata.	*None.
Stem Rust	Early June to July.	As for leaf rust.	Eradicate barberry.
Mildew	Late fall.	Over-wintering mycelium produce spores. These spores infect other plants.	*None.
Dwarf Bunt	After seed is sown.	Spores already in the ground germinate and attack the young seedling.	*None.

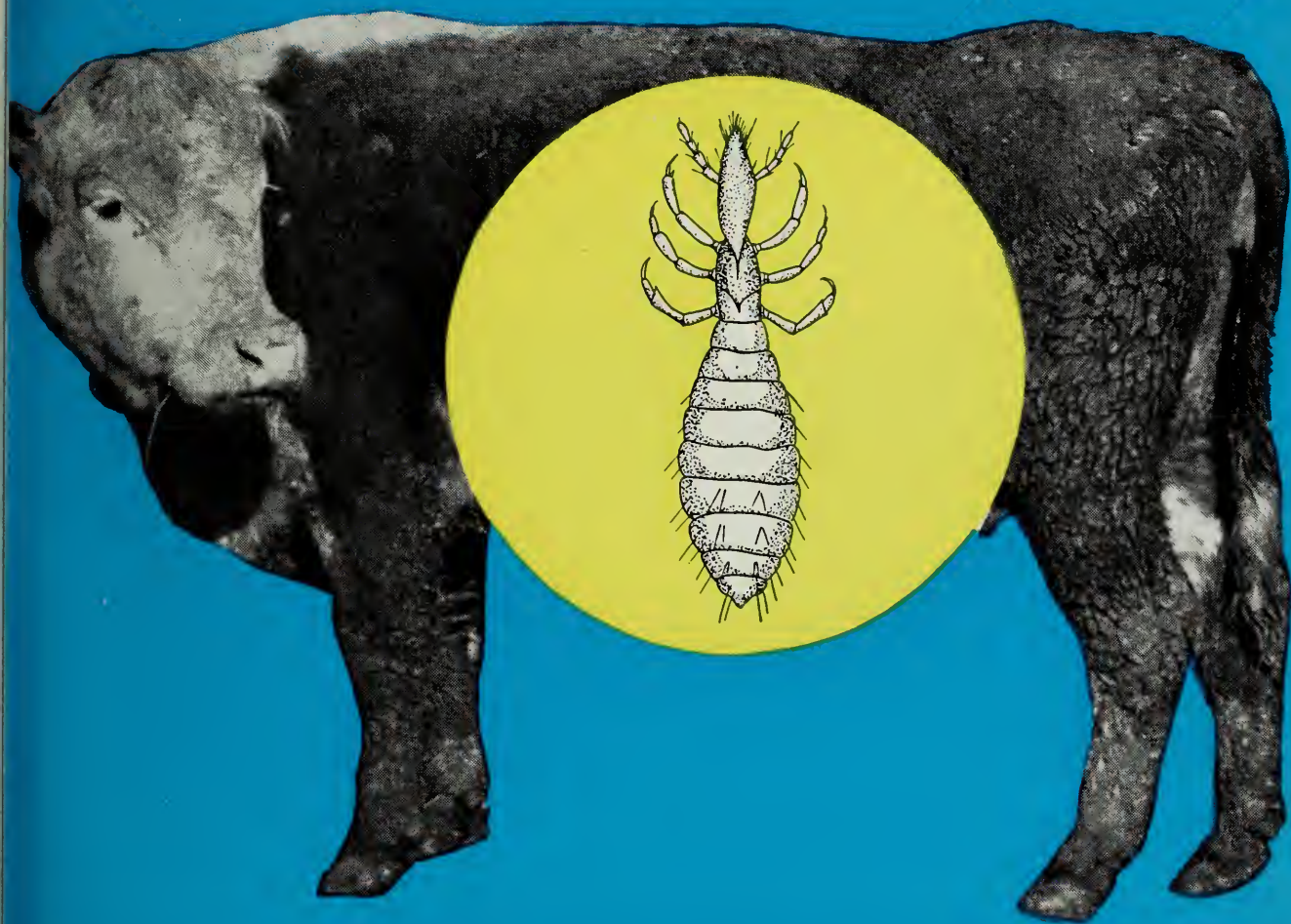
*The only hope of controlling these diseases appears to lie in the production of new, resistant varieties.



CATTLE LICE

and how to control them

ONTARIO VETERINARY COLLEGE, GUELPH, ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

This bulletin has been prepared in good faith to assist those who read it; however, no treatments should be given to animals unless due precautions are taken and in the absence of contraindications and then only by a person or persons qualified to do so. Neither the Ontario Department of Agriculture nor any person or persons employed in writing this bulletin will be liable for any losses or claims actual or implied which might arise.



FIG. 1. The above animal, too weak to rise, is one of a large herd in which fifteen animals died from lousiness before the condition was controlled.

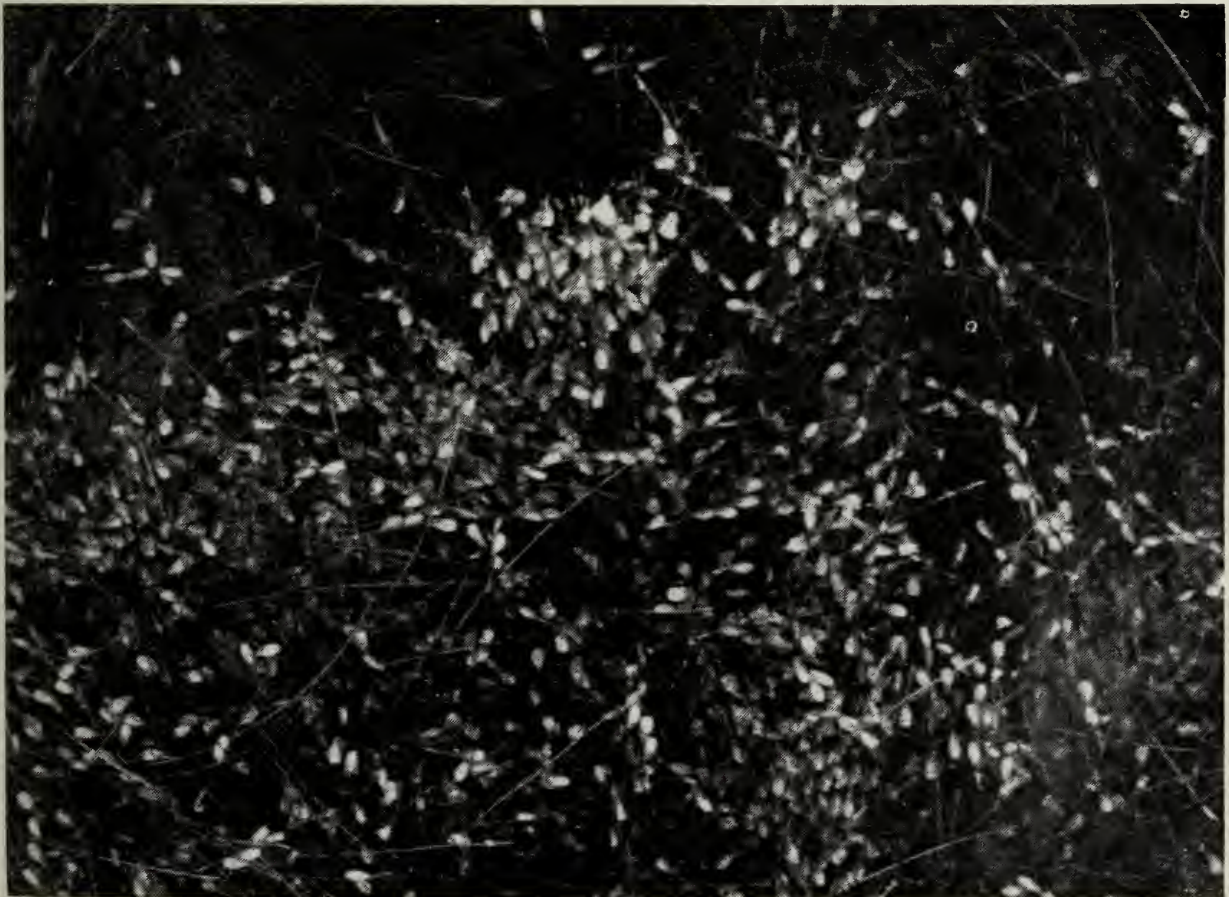


FIG. 2. Cattle hair with numerous lice and eggs as they may be seen with the aid of a magnifying glass.

CATTLE LICE

Profits Increase as Lice Decrease

Prepared by

A. A. Kingscote, J. K. McGregor and D. J. Campbell*

Introduction

Lice are among the most common parasites of cattle. They are small, wingless, and flattened insects. It is believed that they are descendents of book and bark lice. Cattle lice spend their entire life on the bodies of dairy or beef animals and do not normally infest man, or any other farm animals.

The biting, sucking, and crawling of lice causes various degrees of skin irritation, unthriftiness, and loss of profits in both dairy and beef herds. Lousiness and pediculosis are terms used to describe louse infestations.

The purpose of this pamphlet is to review briefly our present knowledge of cattle lice and methods for their eradication.

Effects of Lousiness upon Cattle

Lice are injurious to all ages and types of cattle. The damage caused and losses sustained are not always noticed. Animals do not lose weight and bloom suddenly but are affected over a prolonged period. Cattle producers unnecessarily bear hidden financial loss annually as a result of lousiness in their stock.

Some livestock men are well aware of the losses produced by lice infestations, and take adequate steps to control them early when the cattle are first brought in off pasture for the winter. Other livestock owners who do not realize the harmful nature of lice, eventually become aware of lousiness in their herds when they see large patches of skin scraped, scratched and bruised, or devoid of hair due to rubbing.

Lice in large numbers may produce raw, open sores resembling mange lesions, or they may constantly suck the blood and other body fluids. It is possible that even a few cattle lice may at times cause severe lesions and symptoms in the form of allergic reactions, especially just after an animal becomes infected. Badly infected animals are often unthrifty. Milk production and weight gains are markedly reduced. Constant irritation

*Department of Parasitology, Ontario Veterinary College, Guelph, Canada.

and torment cause digestive upset, lowered vitality, susceptibility to other disease, and stunted growth. Continued licking results in balls of hair forming in the digestive tract.

Seasonal Occurrence and Susceptibility

Lousiness in cattle is a condition of the winter season when housing, overcrowding, and removal of the animals from the cleansing effect of the weather promote rapid increase and spread of lice on the cattle. Starvation and hardship are associated often with lousiness. The louse population increases gradually where conditions are favourable until a peak period is reached towards spring. Some infestations of lice on animals are very severe.

Of course, all animals in a herd are not equally affected. Some cattle appear to be almost immune while other animals are habitually lousy. Severely affected cattle may be detected by their poor, weak, unthrifty appearance. A check on an animal's skin will indicate quickly whether or not lice are present.

Diagnosis of Lousiness

To ascertain if cattle are infested with lice, the animals must be firmly restrained and examined in a good light. The hair should then be divided and the underlying skin examined about the ears, neck, dewlap, back, tail head, switch, and between the hind legs. Lice are visible to the naked eye. The brownish biting lice may be seen moving about. The bluish sucking lice are often seen stationary with their mouth parts deeply buried in the skin. The eggs of all species of lice are seen easily where they are attached to the hair. (See Figs. 2 and 3.)



FIG. 3. Eggs of Biting Cattle Louse (x 20)

Care must be taken that lice infestations are not concealing the lesions of cattle mange, which is a contagious disease that must be reported to the Health of Animals Branch, Canada Department of Agriculture. In cases where there are suspicious lesions, arrangement should be made to have proper skin scrapings made for microscopic examination in a veterinarian's laboratory. Ring worm is another skin condition in cattle which may occur simultaneously with lousiness.

Lice are more likely to become numerous on bulls, dry cows, and young stock rather than on milking cows which are receiving good care.

Various Species of Lice Occurring on Cattle

Four species of lice are found on cattle but only three of them occur commonly. All species may occur in the one herd at the same time.

Cattle lice are of two types (a) biting, (b) sucking.

(a) **Biting lice** — The biting louse* is small, reddish brown, with bars on the upper part of the abdomen. The head is broad and blunt, curved in the front, and equipped with concealed biting mouth parts. These lice are surface feeders which exist on skin scales and exudates, and are found on those parts of the skin where they are disturbed least; for example, on the tail, head, withers, neck, and elsewhere.

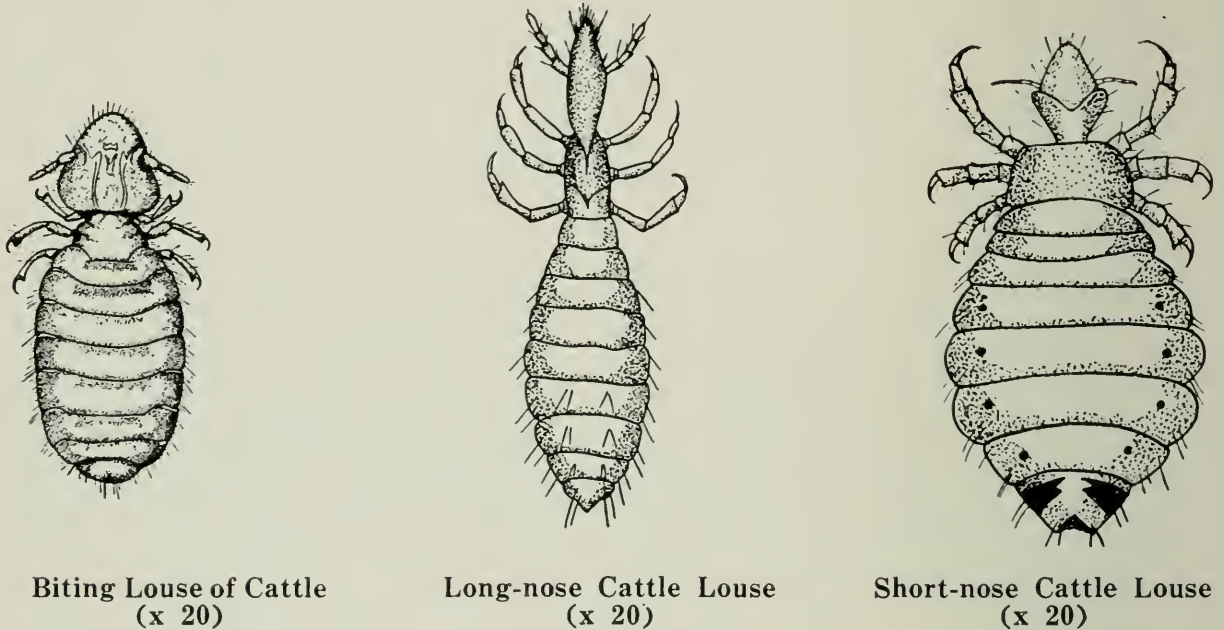


FIG. 4. Common cattle lice (x 20)

(b) **Sucking lice**** — are larger than biting lice. They are long bodied, short nosed, and are often called “blue lice”, since their intestines contain cattle blood, partially digested, which gives the abdomen of the lice a bluish-grey appearance. The light brown head and thorax are slender and elongated. The small mouth parts form a tube suitable for piercing the skin and sucking the blood. Sucking lice prefer the sides of the neck, the brisket, the inner sides of the legs, the back, the head, the area around the eyes, the muzzle, and the ears of cattle. Sucking lice are irritating, and therefore more harmful to cattle than are biting lice. In heavy infestations the entire skin surface may be affected.

The little blue louse*** is the fourth species which infest cattle.

Habits and Life History of Cattle Lice

Cattle lice rarely affect any other animals except accidentally and then for a short time only. There is a natural rise and decline in the numbers of lice found on animals at various times of the year. They increase

**Damalinia* = (*Bovicola*) *bovis*

***Linognathus vituli* and *Haematopinus eurysternus*

in the winter but during the spring and summer when cattle are on pasture, exposed to rain and sun, the lice may nearly all disappear, partly due to exposure and possibly due to improvement in general nutrition and resistance to disease. Lice decline to a small number on pastured cattle. The few that survive the summer are the parents of numerous generations of lice which develop during the winter in herds of cattle where conditions favour their increase.

All the lice described above are wholly dependent on cattle for a living. Adult biting lice may survive a week away from animals whereas the sucking lice may live only three or four days. The eggs of both types of lice are small, oval bodies which are glued to the hairs of the animals (see Figs. 2 and 3). These eggs hatch in 10 to 20 days and mature lice are found about 11 days later. Should the eggs be removed from the host, they usually do not develop unless the temperature is about 80°F or higher; even then a large number of eggs fail to hatch. The young lice that do emerge must find a suitable host in a day or two or they perish. Lice spread from animal to animal chiefly by contact.

CONTROL MEASURES

General Conditions

The control of cattle lice should begin in the fall when their numbers on animals are few. The stockman has at his disposal both physical and chemical means for the control of lice. Physical control measures include the practice of cleaning and brushing cattle down while they are in winter quarters. This reduces the eggs and lice that may be present in the hair. Clipping animals once or twice during the time they are kept indoors is a helpful measure in reducing lice populations. The earlier such measures are begun after the cattle are brought into their winter quarters, the better will be the results. The thoroughness with which first treatments are applied may also reduce the number of subsequent treatments necessary.

Such practices described above, will also assist chemical treatments where heavy infestations demand more vigorous action.

Methods of Application — Sprays, Dips, Dusts and Rubs.

Insecticides may be applied as dusts, sprays, dips or rubs. Each method has its own merits. Hand spraying, knapsack spraying, or dusting are the most practical methods to use in small herds. The use of pressure equipment for spraying large herds is increasing in popularity. Many cattle can be handled efficiently with such equipment. The most successful method is to spray directly against the lay of the hair using not over 400 pounds pressure and using sufficient insecticide to wet the skin. Generally one, or more gallons of spray per head is required, depending upon the time of year and the length and density of the hair.

In the fall, hand or power spraying is best done on days that are mild and sunny. The treatment prevents a heavy winter build-up of lice. The effectiveness of insecticides is reduced when they are applied in cold weather.

Dipping may be useful where large numbers of cattle are assembled. This method of treatment is not always practicable except under range conditions and in suitable weather.

****Solenoptes capillatus*

In winter, insecticidal dusting powders are preferable to sprays or dips especially for dairy animals. This is also true where only a few animals are to be treated and where spray equipment may not be available. Dusts may be applied by hand by using a coarse brush to scrub the insecticide well into the hair to bring it into contact with the skin. The precautions and dosage rate printed on the manufacturer's label should be closely followed.

When dusts are used, all small areas of skin surface must be treated to prevent re-infestation by any surviving lice. The head, ears, neck, brisket, underline, flank, tail head, and switch of each animal should be thoroughly treated.

Rubs consist of various and often ingenious devices, in which sack-ing or other suitable materials are impregnated with insecticides, and made available to cattle upon which to rub themselves whenever they are inclined. Good results have been reported following the continual use of rubs. These devices, however, though they may be very helpful in reducing louse populations and well worth while installing, are not likely to insure thorough treatment of all parts of the body.

Automatic treadle sprayers, used chiefly for fly control, might also help reduce lice

Unfortunately, no insecticide yet available affects the lice eggs attached to the hair. To kill newly hatched lice and to ensure complete coverage of the treated animals, at least two treatments, ten to fourteen days apart are usually necessary. This time between treatments should be observed definitely for the reason that if it is given too early, the lice forming in the eggs but not yet hatched, may escape destruction. On the other hand, second treatments given too late miss the new batches of eggs and the whole control programme, to be effective, may have to be started over again.

Treatments for Cattle Lice

Raw linseed oil is one of the oldest remedies for cattle lice. Other preparations which have been used for a long time include dusts of derris, tobacco, sabadilla, pyrethrum, hellebore, sulphur, arsenic dips, sprays of derris, tobacco, coal tar creosote, commercial grade creolin, and a number of proprietary preparations. Sodium fluoride has been used also for biting lice.

In recent times, extensive experimental work has resulted in many improvements in insecticides either as a result of discovering new substances or by refining the preparation of the older ones. The following sections include those insecticides generally approved and now in use. Undoubtedly others will be added constantly to those listed.

Selection of treatments from the following lists should be governed by the number of cattle involved, the type of treatment which the owner prefers to us (aerosol, spray or dip), the time of the year, local availability of the insecticide, current prices and whether the animals to be treated fall into Section A or Section B classes of livestock as indicated in the following pages. Help and guidance in the choice of insecticides may be obtained from veterinarians, agricultural representatives and farmers' co-operative stores or others who commonly handle livestock preparations. Although the formulations are given here, it will often be more convenient

and generally more satisfactory to obtain ready prepared dry or wettable powders, or emulsion concentrates. In every case, the manufacturer's directions for use and precautions to be taken should be carefully read and followed to get the best results in louse control.



FIG. 5. SELF-TREATING RUBBING DEVICE FOR LOUSE CONTROL ON CATTLE (After Rogoff)

Two fence posts, about 16 feet apart, are set firmly in the ground and braced. Between them a chain, wire, rope or three strands of barbed wire, wrapped with a fourth, are suspended so as to hang about 18 inches above the ground. The cable is then wrapped with burlap sacks and tied every few inches with binder twine. The burlap sacks are soaked till wet with an insecticidal solution poured from a pitcher. The soaking should be repeated about every two weeks. Experimental work has shown, DDT, toxaphene, chlordane and methoxychlor made up in five percent suspensions are all quite effective for soaking the burlap sacking. Only methoxychlor, however, is recommended for milking cattle. The automatic rubbing device is not as satisfactory as thorough spraying or dipping, when such methods are available for use.

SECTION A

LOUSE TREATMENTS FOR DAIRY CATTLE, CALVES UNDER THREE MONTHS OF AGE, AND BEEF CATTLE WITHIN TWO MONTHS OF BUTCHERING.

AEROSOLS

PYRETHRINS (3%), PIPERONYL BUTOXIDE (3%)
METHOXYCHLOR (3%)

Available in pressure containers ready for use.

Follow manufacturer's directions.

SPRAYS

METHOXYCHLOR EMULSION SPRAY

(0.25 to 0.5%)

To make, obtain 25% emulsifiable concentrate. Use at the rate of one to two gallons of concentrate to 100 gallons of water.

PYRETHRINS (0.05%) AND PIPERONYL BUTOXIDE (0.5%)
EMULSION SPRAY

To make, obtain concentrate, and follow manufacturer's directions for mixing with water

ROTENONE SUSPENSION SPRAY

(0.05%)

To make, obtain cubé or derris root powder containing 5% rotenone. Add ten pounds of the powder to 100 gallons of water. Ten pounds of wettable sulphur may be added, or one ounce of detergent may be added to each 6 gallons of water to facilitate mixing.

DIPS

ROTENONE SUSPENSION DIP

(0.05%)

To make, obtain cubé or derris root powder containing 5% rotenone. Add ten pounds of the powder to each 100 gallons of water required. Ten pounds wettable sulphur may be added, or one ounce of detergent may be added to each 6 gallons of water to facilitate mixing.

DUSTS

METHOXYCHLOR DUST

(10%)

Obtain proprietary 10% dust mixed ready for use. **Avoid contamination of food or inhalation.**

ROTENONE DUST

(1.0%)

Mix one pound of cubé or derris root powder containing 5% rotenone with four pounds talc, or, more conveniently purchase machine-mixed products ready for use. Half-strength may be added to bedding at the rate of one pound to each 20 square feet. Rotenone loses insecticidal power with age.

SECTION B

LOUSE TREATMENTS FOR BEEF CATTLE BUT NOT FOR DAIRY CATTLE OR CALVES UNDER THREE MONTHS OF AGE.

(The preparations listed in Section A may be used also for beef animals.)

SPRAYS

CHLORDANE SUSPENSION SPRAY

(0.25% to 0.5%)

To make, obtain 50% wettable chlordane powder. Add four to eight pounds of the powder to 80 gallons of water. **Apply once only.**

Not to be used on animals within one month of butchering.

CHLORDANE EMULSION SPRAY

(0.25% to 0.5%)

To make, obtain chlordane emulsifiable concentrate. Mix with water according to each manufacturer's directions. **Apply once only.**

Not to be used on animals within one month of butchering.

DDD (TDE) SUSPENSION SPRAY

(0.5%)

To make, obtain wettable DDD (TDE) powder. Mix with water according to each manufacturer's directions.

Not to be used on animals within two months of butchering.

DDT SUSPENSION SPRAY

(0.25% to 0.5%)

To make, obtain 50% wettable DDT powder. Add four to eight pounds of this powder to 80 gallons of water. Do not use more than one gallon per animal

Not to be used on animals within two months of butchering.

DDT EMULSION SPRAY

(0.25% to 0.5%)

To make, obtain 25% emulsifiable concentrate. Add one to two gallons of this concentrate to 100 gallons of water.

Not to be used on animals within two months of butchering.

LINDANE SUSPENSION SPRAY

(0.03% to 0.05%)

To make, obtain 12% wettable lindane powder. Add two to three pounds of this powder to 80 gallons of water (if 25% wettable powder is used add only one to one-and-a-half pounds of the powder to 80 gallons of water.)

Not to be used on animals within one month of butchering.

LINDANE EMULSION SPRAY

(0.03% to 0.05%)

To make, obtain 20% emulsifiable lindane concentrate. Add one to one-and-a-half pints of this concentrate to 80 gallons of water.

Not to be used on animals within one month of butchering.

BHC SUSPENSION SPRAY

(0.025% to 0.05% gamma BHC)

To make, obtain wettable powder. Mix with water according to each manufacturer's directions.

Not to be used on animals within one month of butchering. Do not use in dairy barns or where milk is being handled because of odour and taint hazards.

TOXAPHENE SUSPENSION SPRAY

(0.25% to 0.5%)

To make, obtain 40% wettable toxaphene powder. Add five to ten pounds of this powder to 80 gallons of water.

Not to be used on animals within two weeks of butchering.

TOXAPHENE EMULSION SPRAY

(0.25% to 0.5%)

To make obtain emulsifiable concentrate. Mix with water according to each manufacturer's directions.

Not to be used on animals within two weeks of butchering.

All sprays listed in Section A may be used on beef animals also.

DIPS

LINDANE SUSPENSION DIP

(0.015%)

To make, obtain 12% wettable powder. Add one pound of this powder to each 80 gallons of water required.

Not to be used on animals within two months of butchering.

TOXAPHENE SUSPENSION DIP

(0.25% to 0.5%)

To make, obtain 40% wettable toxaphene powder. Add five to ten pounds of this powder to each 80 gallons of water required.

Not to be used on animals within two weeks of butchering, or as a dip for calves under six months of age.

TOXAPHENE EMULSION DIP

(0.25% to 0.5%)

To make, obtain toxaphene emulsifiable concentrate. Mix with water according to each manufacturer's directions.

Not to be used on animals within two weeks of butchering, or as a dip for calves under six months of age.

BHC SUSPENSION DIP

(0.015% gamma)

To make, obtain wettable powder. Mix with water according to each manufacturer's directions.

Not to be used on animals within two months of butchering, or on calves under three months of age.

All dips listed in Section A may be used on beef animals also.

DUSTS
LINDANE DUST
(0.5%)

Obtain proprietary dust ready for use.

Not to be used on animals within two months of butchering, or on calves under three months of age.

CHLORDANE DUST
(2.0%)

Obtain proprietary dust ready for use.

Not to be used on animals being finished for butchering, or on calves under three months of age.

All dusts listed in Section A may be used on beef animals also.

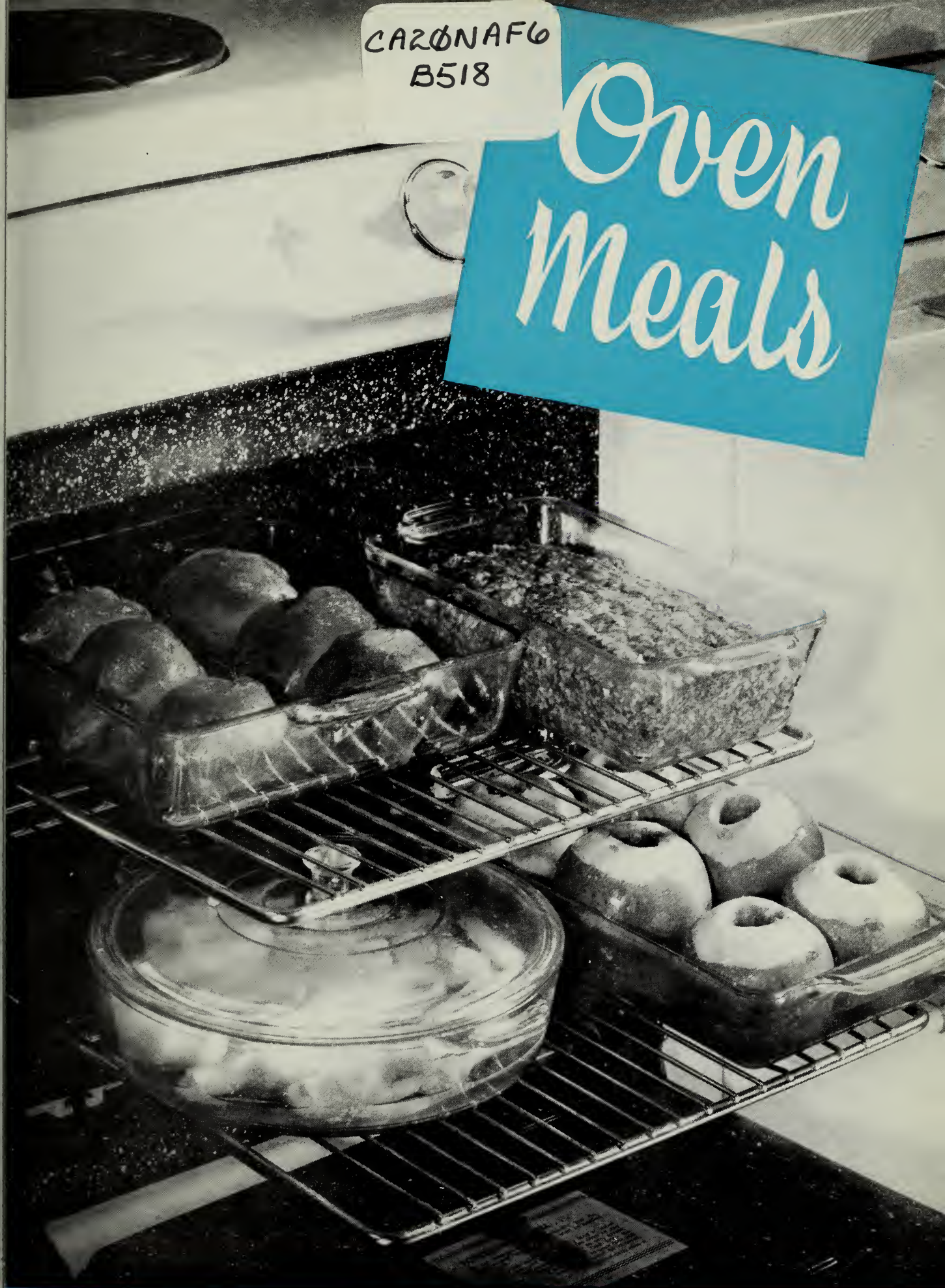
SUMMARY

1. Young and poorly fed cattle raised under crowded conditions are most susceptible to lice infestations.
2. Examine cattle regularly for signs of lice and take vigorous action to prevent multiplication and spread of these parasites at once.
3. Early treatment of cattle when they are brought into winter quarters prevents loss of health, unnecessary damage and torment of animals later in the winter.
4. Proper application of insecticides will destroy both sucking and biting lice that may be present on cattle.
5. At least two treatments 10 to 14 days apart should be given. The first treatment kills the adult lice, the second one destroys the newly born lice before they mature to lay eggs.
6. Observe the precautions printed on the labels of the package by the manufacturers of insecticides. Do not exceed or dilute the dose rate prescribed.
7. Various effective insecticides that can be conveniently used in several ways are available. Their cost is small in comparison to the benefits derived.
8. Treat any new animals being added to the herd.



CARONAF6
B518

Oven Meals



BULLETIN 518

NUTRITION SECTION

JANUARY, 1957

EXTENSION BRANCH • HOME ECONOMICS SERVICE

ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA



Rolled Oats Muffins

SERVE THEM FRESH FROM YOUR OVEN

See recipe, page 26.

OVEN MEALS

Table of Contents

All recipes in this book were tested and approved by Home Economists of the Nutrition Section of the Extension Branch, Home Economics Service. Standard measurements were used in every recipe.

	PAGE
INTRODUCTION	3- 8
TEMPERATURE AND TIME CHARTS	9-12
TIPS ON PREPARING OVEN MEALS	13
MENUS FOR OVEN MEALS	14-15
MEATS, FISH, SAUCES AND CASSEROLE DISHES	16-21
VEGETABLES, SALADS AND SALAD DRESSINGS	21-24
FLOUR MIXTURES AND DESSERTS	24-28

Measurement Abbreviations

cup	c.
tablespoon	tbsp.
teaspoon	tsp.
few grains	f.g.

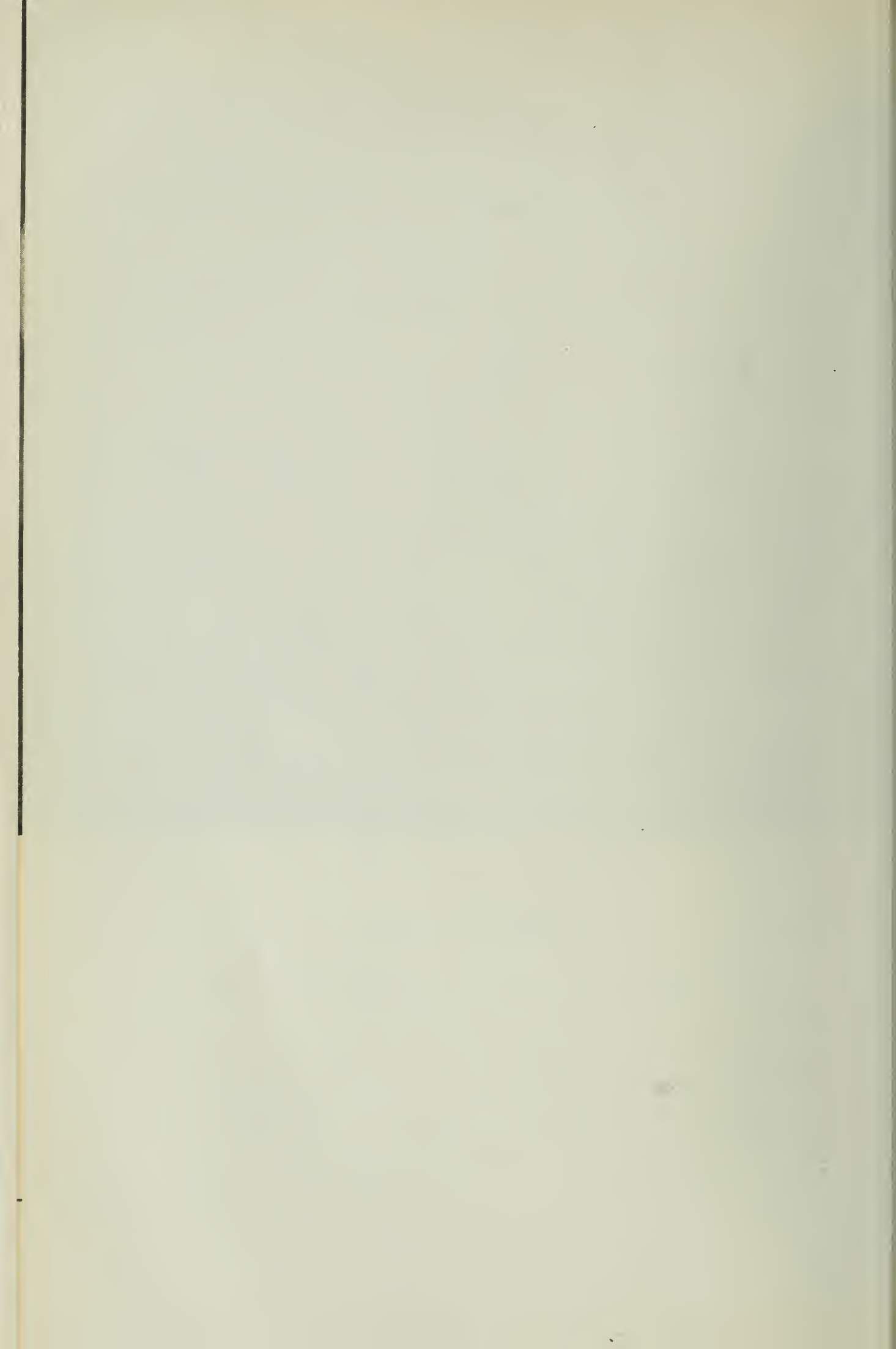
Equivalents

1 c.	=	8 oz.
16 tbsp.	=	1 c.
3 tsp.	=	1 tbsp.

Terms commonly used to describe Oven Temperatures

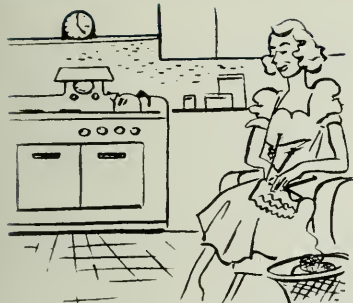
Slow oven	250°-350°	Hot oven	400°-450°
Moderate oven	350°-400°	Very hot oven	450°-550°

See Temperature and Time Charts, pages 9-12.



Capture the Secrets of Oven Meals

SAVE TIME AND WORK



Oven meals give homemakers a sense of freedom. When food is cooked in the oven, we need not stand over a hot stove, stirring or watching for that pot to boil. In oven cookery, *we* do our part in preparing the food and regulating the oven. Then the *oven* does the work and shares the responsibility.

SAVE DISHES



Cut down on extra dish washing.

Plan to serve oven products in the baking dishes.

SAVE FUEL



When we cook a whole meal or most of a meal in the oven we may use less electricity or gas than during top-of-the-stove cooking. Let's save fuel by planning to cook more than one food in the oven at one time.

SAVE FOOD VALUE

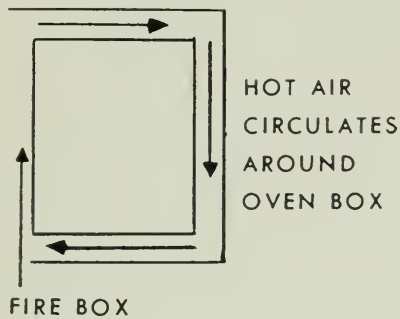


Foods cooked in the oven retain more food value when we follow reliable directions for time and temperature. Let's save those vitamins and minerals.

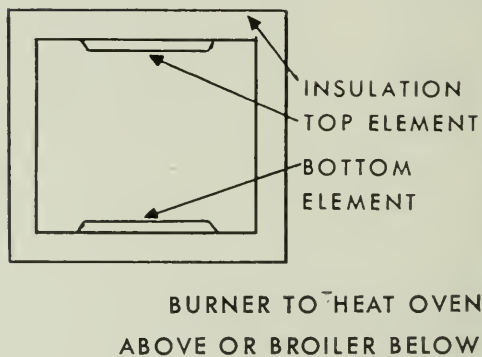
A Few Important Points about the Oven

How is the oven heated? In *wood or coal stoves* the oven is heated by circulation of hot air, controlled by the amount and type of fuel. In *electric stoves* the oven is heated by top and bottom units controlled by a switch. Newer *gas stoves* have one burner at the bottom of the oven. This burner also heats the broiler underneath the oven.

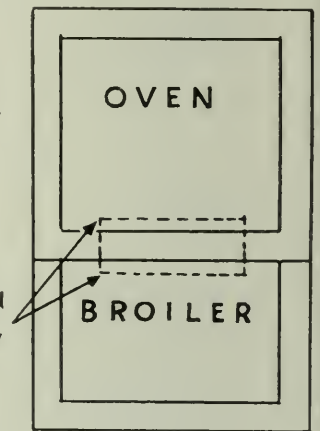
COAL AND WOOD STOVE
OVEN



ELECTRIC STOVE
OVEN



GAS STOVE
OVEN



Ovens are *insulated* to keep the heat in and make oven temperature regulation possible. To protect the insulation of a gas or electric oven, cool the oven thoroughly after each use. Slow cooling (with oven door closed) may result in rotted or damp insulating material.

Don't guess about oven temperatures. If your oven has no thermometer, a movable *oven thermometer* is inexpensive to buy. Place the movable thermometer in the oven before heating, on the same level as the food to be baked. Place the thermometer so it can be read easily and quickly. An outside oven control may require regulation from time to time and may not be a dependable guide to temperature. Check the inside thermometer readings with the control or outside thermometer.

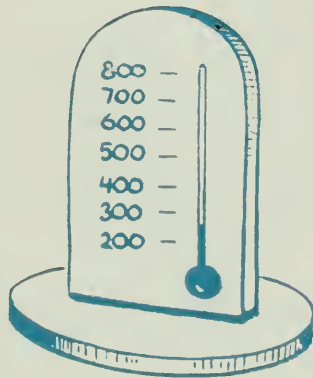
The *lining of the oven* is usually finished with enamel or porcelain. It should be cleaned often with warm soapy water, a good cleanser or fine steel wool.

The *movable shelves* should be used to allow free circulation of air around all surfaces of the baking pan. This helps us to turn out a beautifully browned, well-baked product.

If you have a new stove, be sure to study the manufacturer's booklet. Follow instructions given for the operation of the stove.

What Are Good Oven Utensils?

- Good utensils save both time and money, regardless of the type of oven used. When possible use the type of utensil suggested in the recipes.
- If the pans are warped, unevenly darkened or too deep for the amount of food placed in them, you will have uneven baking and browning.
- Flat bottoms and straight sides conserve heat in your utensil.
- Metal pans should be lightweight, bright and smooth to give best results.
- Roasting pans should be shallow and open and should be fitted with a rack.
- Glass and earthenware are practical and attractive since the food may be baked and served in the same dish. When glass utensils are used in place of metal utensils, a 25° lower oven temperature or a shorter baking time is recommended.



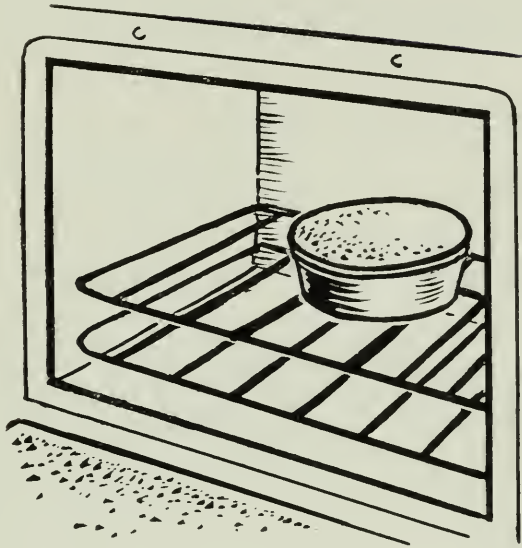
One type of movable oven thermometer.

What Is Good Arrangement of Oven Utensils?

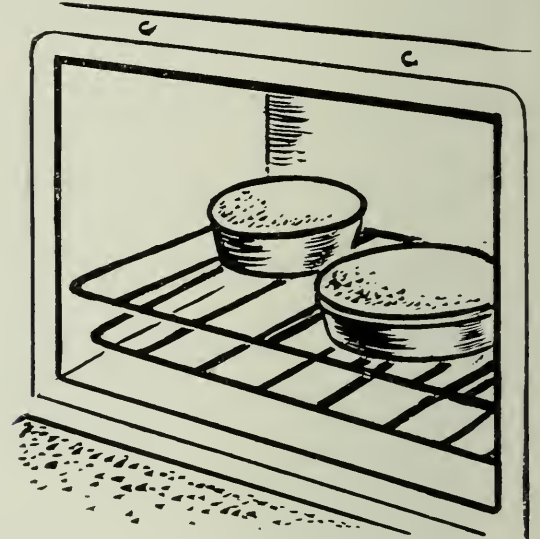
- Make sure there are enough utensils for the oven meal you plan and that these will fit together without crowding in the oven.
- Adjust racks before heating oven. In this way there is minimum heat loss when foods are placed in oven.
- Place food dishes that require attention during baking at the front of the oven.

Arranging Pans in the Oven

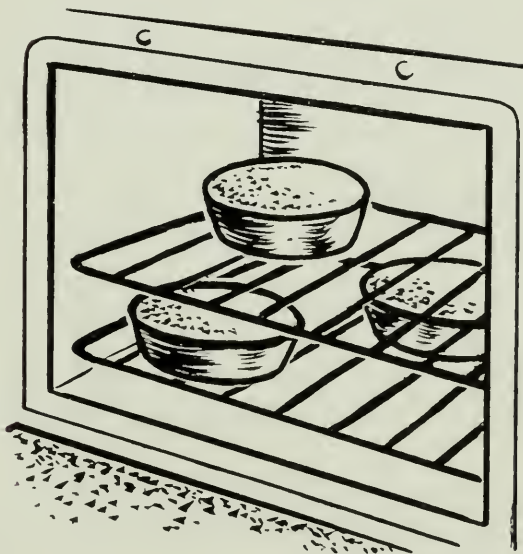
Place single pan in centre of oven on rack.



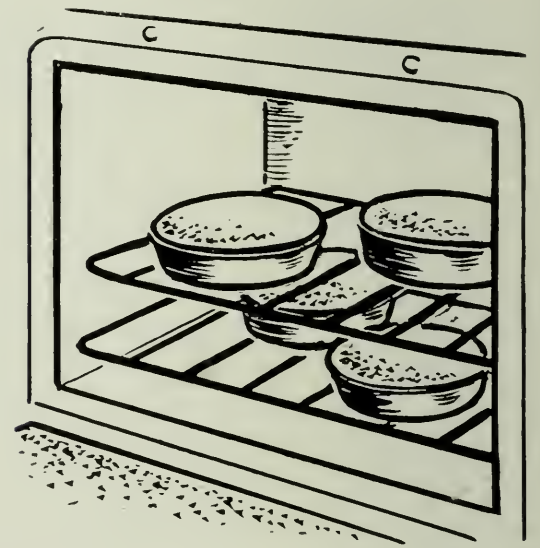
Place two pans on rack in centre of oven. Arrange so that pans do not touch each other or walls of oven.



Place three pans on two racks so that no pan is directly above another. Pans should not touch each other or oven walls.



To arrange four pans, place two on lower rack and two on upper rack, so that no pan is directly above another. Pans should not touch each other or oven walls.



What Are Good Oven Meals?

Good meals, whether cooked in the oven or on top of the stove, are planned meals. Smart planners serve the foods recommended in Food Guide for Health every day.

FOOD GUIDE FOR HEALTH

Based on Canada's Food Rules

These foods are good to eat.

Eat them every day for health.

Have at least three meals each day.

1. MILK — Children (up to about 12): at least 1 pint. Adolescents: at least 1½ pints. Adults: at least ½ pint.
2. FRUIT — One serving of tomatoes or citrus fruit or their juices; and one serving of other fruit.
3. VEGETABLES — At least one serving of potatoes; and at least two servings of other vegetables, preferably leafy, green or yellow and frequently raw.
4. CEREALS AND BREAD — One serving of whole grain cereal, and at least four slices of bread with butter.
5. MEAT AND FISH — One serving of meat, fish, poultry or meat alternates such as dried beans, eggs and cheese. Use LIVER frequently.

IN ADDITION:

Eggs and cheese at least three times a week each.

Vitamin D — At least 400 International Units daily for all growing persons and for expectant and nursing mothers.



Remember in Planning Meals

Menu planning can be fun!

Such a variety of foods to choose!

FOOD VALUES

Most important, our meals should include the foods for health. Food Guide for Health, on page 7, is a guide to planning good healthful meals. First of all we make certain that the foods recommended in Food Guide for Health are included in each day's meals. After that, we can add other food such as muffins, biscuits, cakes and pies to our menus.

Plan menus for the day, or even better, plan meals for a week at a time.

FLAVOUR

We think of foods as being either mild or very definite in flavour. Contrasts such as ham and mustard, liver and onions, strawberries and cream are all-time favourite combinations. Strong, sharp or acid flavoured foods need mild flavoured foods to "go with" them.

COLOUR

As in clothes, so in food, some colours look well together. Others may either clash or seem very drab when placed side by side. Let's keep those dinner plates interesting. Always have one bright vegetable on the plate. And remember those garnishes too! A sprig of parsley, a dash of paprika or a slice of lemon may add just the touch of colour you need to dress up a meal.

TEXTURE

To make a meal really interesting, plan to serve something crisp or crunchy with soft foods: a cookie with a soft dessert; crisp salad with macaroni and cheese or pork and beans. A meal shouldn't be too dry or too soft. So in planning food combinations avoid two mashed vegetables or two sauces on one plate. Variety both in texture and shapes is wise.

*Do have a menu planning bee,
Food Guide for Health will hold the key,
But colour, flavour and texture too,
All play a part in the job you do.*

Temperature and Time Charts

SLOW OVEN: 250°-350°

	OVEN TEMPERA- TURE	APPROXIMATE BAKING TIME HOURS			INTERNAL TEMPERA- TURE
MEATS					
(See pages 16-18.)					
Beef	325°	4 lb.	6 lb.	8 lb.	
Standing ribs					
Rare.....		1¾	2¼	3	140°
Medium.....		2	2½	3½	160°
Well done.....		2⅓	3⅓	4½	170°
Rolled ribs					
Rare.....		2¼	3		140°
Medium.....		2½	3⅓		160°
Well done.....		2¾	4		170°
Lamb — well done	325°	6 lb.	8 lb.		
Leg.....		3½	4⅔		182°
		3 lb.	5 lb.		
Crown.....			3¾		182°
Shoulder.....		1¾	3		182°
Shoulder, boned and rolled.....		2	2½		182°
Veal — well done	325°	4 lb.	5 lb.	8 lb.	
Leg.....			3⅓	4	180°
Loin.....			3	4	180°
Shoulder.....			3⅓	4⅔	180°
Shoulder, boned and rolled.....		2⅔		4	180°
Pork — fresh, well done	325°	5 lb.	8 lb.	10 lb.	
Leg.....		4¼	5⅓	6½	185°
Loin.....		3⅓			185°
Shoulder.....		3⅓	5		185°
Pork — cured and smoked		9 lb.	11 lb.	13 lb.	
Ham, leg.....		3	3¼	3½	150°
(See Note 1, page 16.)					
		4-6 lb.	6-8 lb.		
Picnic shoulder, hockless.....		2-3	3-3¼		170°
(See Note 2, page 16.)					
		3-5 lb.	5-7 lb.		
Picnic shoulder, boneless.....		2¼-3¼	3-4		170°
Cottage style pork shoulder.....		2¼-3¼	3-4		170°

Temperature and Time Charts—continued

— SLOW OVEN: 250°-350° —

CAKES AND DESSERTS	OVEN TEMPERA- TURE	APPROXIMATE BAKING TIME MINUTES
Angel cake.....	275°-300°	60-75
Gingerbread.....	325°-350°	35-45
Bread pudding, large.....	325°-350°	50
small.....	325°-350°	25
Custard, large.....	325°-350°	60
small (Recipe, page 27)	325°-350°	30
Meringue on pie or pudding (Recipe, page 25)	325°-350°	15
Rice or tapioca (Recipe, page 27) ...	250°-350°	60-90

SOUFFLÉS

(Recipe, page 22)	325°	60-90
-------------------------	------	-------

VEGETABLES

Baked beans (Recipe, page 20)	250°-350°	6-8 hours
Potatoes, pan roasted.. ..	325°	60

POULTRY

(See Note 3, page 16.)

		APPROXIMATE BAKING TIME HOURS	INTERNAL† TEMPERA- TURE
		Drawn wt.*	
Chicken	325°	3½ lb.....2½	190°
		4 lb. ....3	190°
Duckling	325°	3½ lb.....2½	190°
Turkey and Goose	325°	8 lb.....3	190°
		10 lb.....3½	190°
		12 lb.....4	190°
		14 lb.....4½	190°
Turkeys over 18 lb.	300°	18 lb.....5½	190°
		25 lb.....6½	190°

* Drawn weight refers to poultry after feathers, head, feet and entrails are removed.

† Poultry is done when meat thermometer placed inside thigh next to the body registers 190°. If meat thermometer is put into stuffing, poultry is done when thermometer registers 180°.

Temperature and Time Charts—continued

MODERATE OVEN: 350°-400°

	OVEN TEMPERATURE	APPROXIMATE BAKING TIME MINUTES
CAKES, COOKIES, DESSERTS		
Batter puddings	350°-400°	35-45
Butter cake, 9" square.....	350°	35-45
loaf.....	350°	45-60
sheet or cup	375°	20-30
layer.....	375°	20
Cookies, drop.....	375°-400°	12-15
thin rolled.....	350°-375°	10-12
Fruit crisp (Recipe, page 28)	350°	50
Prune and apricot upside-down cake (Recipe, page 26)	350°	35
FRUITS		
Apples	350°-375°	20-40
Prunes (Recipe, page 28)	350°-375°	45-60
Rhubarb (Recipe, page 28)	350°-375°	20-40
MEATS, FISH AND CHEESE		
Casseroles (Recipes, pages 19-21)	350°	20-60
Macaroni and cheese (Recipe, page 21)	350°	15-20
Patties (Recipe, page 17)	350°	45-60
Stuffed fish (Recipe, page 18)	350°	40-60
Stuffed liver (Recipe, page 18)	350°	60
Swiss Steak (Recipe, page 17)	350°	60-90
VEGETABLES		
Beets, grated (Recipe, page 21)	350°	50
Carrots, grated (Recipe, page 21)	350°	30-40
Onions, whole.....	350°	45-60
Parsnips, grated or quartered (Recipes, page 21)	350°	30-50
Scalloped dishes, except potatoes.....	350°	15-30
Scalloped potatoes	350°-400°	60-90
Squash, individual serving.....	350°	30-60
Stuffed peppers (Recipe, page 22)	350°-375°	30
Tomatoes (Recipe, page 23)	350°	20-30

Temperature and Time Charts—continued

HOT OVEN: 400°-450°

	OVEN TEMPERATURE	APPROXIMATE BAKING TIME MINUTES
DESSERTS AND FRUIT		
Bananas.....	400°-450°	15-20
Plum roll (Recipe, page 25)	400°	30
MEAT		
Meat biscuit roll (Recipe, page 17)	400°	20
MUFFINS		
(Recipes, pages 26-27)	400°-425°	15-25
PASTRY		
Double crust, fresh fruit pie	425°	20
	then 350°	20
Double crust, cooked fruit pie	425°	35
Single crust, custard or pumpkin pie.....	450°	10-12
	then 325°-350°	30
Meat pie with crust, meat previously cooked	450°	30
VEGETABLES		
Potatoes, whole (Recipe, page 23)	425°-500°	40-60
Sweet potatoes and yams, whole.....	425°-450°	25-60

VERY HOT OVEN: 450°-500°

	OVEN TEMPERATURE	APPROXIMATE BAKING TIME MINUTES
FISH (fillets)		
(Recipe, page 18)	450°-500°	10-15
PASTRY		
Pie shell (Recipe, page 24)	450°	12-15
TEA BISCUITS		
(Recipe, page 25)	450°-500°	10-12
VEGETABLES		
Potatoes, whole (Recipe, page 23) ..	425°-500°	40-60

Tips on Preparing Oven Meals

- Plan for food dishes which require about the same oven temperature. And check the length of time each dish requires for cooking. Draw up a time plan. See Temperature and Time Charts, pages 9-12.
- Place food dishes that require the longest baking period in oven first. Plan so that all food will be ready to serve at the same time. When planning the time to start baking a dessert, consider whether it is to be served hot or cold.
- Place food dishes that require attention during baking at the front of the oven.
- If a lower temperature is needed for one particular dish, oven-poach. To oven-poach, place baking dish in pan and surround with a small amount of hot water, adding more from time to time if necessary.
- Bake and serve in the same dishes where possible.

DRAW UP A TIME PLAN FOR OVEN MEALS



SAMPLE TIME PLAN

MENU

Tomato Juice
Baked Meat Patties (page 17)
Baked Carrots (page 21) Baked Potatoes (page 23)
Whole Wheat Bread
Raisin and Orange Pie (page 24)
Milk and Tea

TIME TABLE

5:00	p.m.	Preheat oven to 450°.
		Start preparation of raisin and orange filling.
5:10	"	Chill tomato juice.
		Scrub potatoes and carrots.
5:15	"	Bake potatoes.
		Prepare and bake pie shell.
5:25	"	Complete pie filling and chill.
5:30	"	Prepare meat patties.
5:40	"	Remove pie shell from oven. Cool.
		Reduce heat to 350°.
		Place patties in oven.
5:45	"	Prepare carrots and bake.
5:55	"	Prepare meringue. Brown in oven (about 15 minutes).
6:05	"	Set table.
6:15	"	Serve meal.

Menus for Oven Meals Baked at Different Temperatures

Plan to include in an oven meal food dishes requiring about the same oven temperature. See the Temperature and Time Charts, pages 9-12. Here are some menus for oven meals to be baked in slow, moderate, hot and very hot ovens.



325°.

Tomato Juice

Roast Beef (pages 9 and 16) and Gravy

Potatoes (pan roasted) Green Vegetable Salad (page 23)

Honey Custard (page 27)

Cookies

Tea

350°

Baked Meat Patties (page 17)

Baked Bean or Soybean Casserole (page 20) Baked Carrots (page 21)

Salad Greens (page 23)

Baked Apples

Cookies

Milk and Tea or Coffee

350°

Swiss Steak (page 17)

Baked Beets (page 21) Baked Stuffed Peppers (page 22)

Raw Turnip Sticks

Prunes and Apricots (page 28) OR

Prune and Apricot Upside-down Cake (page 26)

Milk and Tea or Coffee

350°

Sliced Cold Meat

Macaroni and Cheese (page 21) OR Corn Soufflé (page 22)

Cabbage Salad

Fruit Crisp (page 28)

Tea

375°-400°

Meat Biscuit Roll (page 17)

Baked Potatoes (page 23) Baked Tomatoes (page 23)

Fruit Cup

Wheat Germ Muffins (page 27)

Milk and Tea or Coffee

450°-500°

Baked Fish (page 18) Tomato Sauce (page 19)

Baked Potatoes (page 23) Buttered Peas

Raw Carrot and Turnip Sticks

Raisin and Orange Pie (page 24)

Milk and Tea or Coffee

Meats, Fish, Sauces and Casserole Dishes

Meats

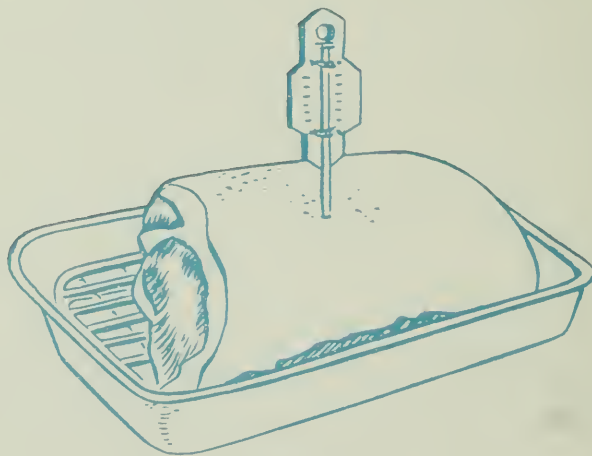
Roasting

For cuts suitable for roasting, see Temperature and Time Charts, page 9.

1. Wipe meat with a clean damp cloth.
2. Place meat fat side up on a rack in an open pan in slow oven, 325°.
3. Do not add water. Do not cover pan.
4. A meat thermometer provides the only true test of doneness. The approximate baking time in Temperature and Time Charts, page 9, is a guide only. Size, shape, fat covering and initial temperature of meat influence length of cooking period.
5. Insert meat thermometer into the thickest part of the meat, not touching bone or fat.
6. For frozen meats and poultry, increase cooking time 10-20 minutes per pound.

NOTE:

1. After baking leg ham, remove rind. Pour off drippings. Cover ham with sugar. Bake in hot oven, 400°, 15-20 minutes or to an internal temperature of 162°.
2. Picnic shoulder may be baked as suggested in Temperature and Time Charts, page 9, if it has a mild cure. When a strong cure has been used picnic shoulder may be cooked in water. Cover meat with warm water, heat gradually and simmer gently (approximately 35 minutes per pound).
3. Roast poultry breast side up on rack in open roasting pan. Cover with metal foil or with cloth that has been dipped in melted fat. Insert meat thermometer inside thigh next to the body. See Temperature and Time Chart, page 10.



Roasting meat is placed fat side up on a rack in an open roasting pan. Insert meat thermometer. The bulb of the thermometer should not touch fat or bone. Do not add water. Use a slow oven, 325°.

Baked Meat Patties

- 1½ lb. ground meat
- ½ c. bread crumbs
- 2 tsp. salt
- ¼ tsp. pepper
- ½ tsp. dry mustard
- 1 onion, diced
- ½ c. vegetable stock, milk or tomato juice

1. Combine all ingredients well.
2. Shape in patties.
3. Bake, on greased pan, in moderate oven, 350°, 45-60 minutes. Serves 6.

Variations — 1. Wrap each patty in strip of bacon. Fasten with toothpick.
2. Put layer of mixture in pan, then layer of bread dressing, then layer of meat.
3. Use ½ c. quick-cooking rolled oats instead of bread crumbs.

Swiss Steak

- 1½ lb. steak cut 1" thick, from shoulder, rump or round
 - ¼ c. seasoned flour fat
 - 1 onion, sliced
 - 2 c. boiling water
- OR
- 1 c. water and 1 c. tomato juice

1. Coat meat in seasoned flour and pound meat well on both sides with edge of plate or meat mallet.
2. Brown meat on both sides in fat. Add onion and brown.
3. Place meat and onion in greased casserole, 1½ qt. size. Add liquid and cover casserole.
4. Bake in moderate oven, 350°, 1-1½ hours, or until meat is tender. Serves 5-6.

NOTE: Swiss steak may be simmered on top of the stove in covered frying pan, 1-1½ hours, or until meat is tender.

Meat Biscuit Roll

recipe of Tea Biscuits, page 25.

- ½ lb. ground meat
- 1 tbsp. onion, diced
- 1 tbsp. fat
- 1 tbsp. flour
- ½ tsp. salt
- f.g. pepper
- ½ c. vegetable or meat stock

1. Brown meat and onion in fat. Add flour, seasonings and stock.
2. Cook until stock is thickened.
3. Spread on biscuit dough, rolled ¼" thick. Roll up like jelly roll.
4. Slice. Place cut side up on greased pan or in muffin tins.
5. Bake in hot oven, 400°, 20 minutes. Serve with gravy or Spicy Tomato Sauce. See recipe, page 19. Serves 6.

Baked Stuffed Liver

BREAD DRESSING

- 1 c. soft bread crumbs
- 1 tbsp. onion, diced
- $\frac{1}{2}$ tsp. sage
- $\frac{1}{4}$ tsp. salt
- liquid to moisten

- 1 lb. liver, cut in wide slices
about $\frac{1}{4}$ " thick
- $\frac{1}{4}$ c. seasoned flour
fat

- 1, 10 oz. tin tomato soup (or mushroom soup or $1\frac{1}{2}$ c. tomato juice)

- 1. Make dressing.
- 2. Roll dressing in slices of liver. Secure with toothpicks or small skewers.
- 3. Roll liver in seasoned flour.
- 4. Brown in fat in frying pan.
- 5. Place in greased casserole, $1\frac{1}{2}$ qt. size.
- 6. Pour soup over rolls. Rinse out soup tin with $\frac{1}{4}$ c. water and add to casserole. Cover.
- 7. Bake in moderate oven, 350° , about 1 hour. Serves 6.

Fish

Baked Stuffed Fish

- 1. Clean, wash and dry fish. Make bread dressing (above).
- 2. Stuff fish loosely. Tie with string.
- 3. Place fish in greased baking pan. Sprinkle with salt and melted fat. Do not add water. Do not cover.
- 4. Bake in moderate oven, 350° , 40-60 minutes or until fish flakes easily when tested with a fork. Baste with melted fat during baking if the fish is dry.

Baked Fillets

- 1. Soak fillets for 3 minutes in $\frac{1}{4}$ c. milk, to which 1 tsp. salt has been added. Drain.
- 2. Place in greased pan. Cover fillets with sifted bread crumbs. Dot with fat.
- 3. Bake, in very hot oven, 450° - 500° , until cooked, about 10-15 minutes. Grated cheese may be sprinkled over top of fish just before removing from oven.



Sauces for Meat and Fish

Barbecue Sauce

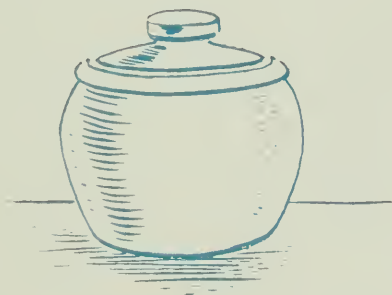
- 1 onion, diced
- 2 tbsp. fat
- 2 tbsp. vinegar
- 2 tbsp. brown sugar
- 4 tbsp. lemon juice
- 1 c. catsup
- 3 tbsp. Worcestershire sauce
- 1 tsp. prepared mustard
- $\frac{1}{2}$ c. water
- $\frac{1}{2}$ c. celery, diced
- f.g. salt
- f.g. cayenne

1. Brown onion in fat.
2. Add remaining ingredients.
3. Cover. Simmer 30 minutes.
Serve with spareribs, short ribs, pork chops, frankfurters, meat patties, etc.

Spicy Tomato Sauce

- $1\frac{1}{2}$ c. canned tomatoes
- 1 slice onion
- 8 cloves
- $\frac{1}{2}$ tsp. salt
- f.g. pepper
- 1 tsp. sugar
- $1\frac{1}{2}$ tbsp. flour
- $1\frac{1}{2}$ tbsp. fat

1. Heat to boiling, tomatoes, onion and seasonings. Simmer 10 minutes.
2. Cream flour and fat in a bowl. Add to tomatoes. Cook and stir till thick.
3. Press through a sieve. Serve hot.
Serve with meat loaf, meat patties, fish, etc.



Casserole Dishes

Fish Casserole

- 2 c. cooked fish, flaked
- $\frac{1}{2}$ c. bread crumbs
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{4}$ tsp. pepper
- 2 tbsp. fat, melted
- 2 eggs, beaten

1. Mix all ingredients.
2. Bake in greased casserole, $1\frac{1}{2}$ qt. size, in moderate oven, 350° , 20 minutes.
Serves 4-5.

Soybean Casserole

- 1 c. soybeans
- 3 c. boiling water and 2 bouillon cubes
- OR
- 3 c. meat stock
- 6 tbsp. flour
- $\frac{1}{8}$ tsp. pepper
- 1 tsp. dry mustard
- $\frac{1}{2}$ c. cold water
- $\frac{1}{4}$ lb. salt pork or bacon, diced
- $\frac{1}{4}$ c. onion, diced
- 1 tbsp. molasses or brown sugar
- 1 tsp. salt
- $\frac{1}{4}$ c. celery, diced (optional)
- 2 tbsp. green pepper, diced (optional)

1. Wash and soak soybeans overnight in cold water. Drain.
2. Cook soybeans in meat stock until tender, about 3 hours in saucepan or 25 minutes in pressure cooker. There should be about 2 cups of liquid left.
3. Mix flour, pepper, mustard and cold water, and add to the beans. Stir.
4. Fry the fat pork, onion, celery and green pepper. (Fat from salt pork or bacon is sufficient.)
5. Add to beans and add molasses or sugar and salt to taste.
6. Turn into greased casserole, $1\frac{1}{2}$ qt. size.
7. Bake, uncovered, in moderate oven, 350° , 30 minutes.

Serves 6.

Baked Beans

- 2 c. dried navy beans
- 1 onion
- $\frac{1}{8}$ lb. salt pork
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{2}$ tsp. dry mustard
- 2 tbsp. molasses

1. Soak beans in cold water overnight.
2. Simmer beans in soaking water until skins begin to burst.
3. Turn beans into bean pot with onion at bottom of pot.
4. Pour boiling water over salt pork. Scrape the rind until white, score in $\frac{1}{2}$ " strips, and bury meat in beans, leaving only rind exposed.
5. Mix salt, mustard and molasses in measuring cup, fill with hot water, stir until well mixed, and pour over pork and beans.
6. Add water to cover beans, then put lid on pot. Bake in slow oven, 250° - 350° , 6-8 hours. If necessary, keep adding water to cover beans. Remove lid during the last hour and lift meat to top of beans to crisp.

Serves 6-8.

Macaroni and Cheese

- 2 c. scalded milk
- 1 tbsp. onion, diced
- 1 c. macaroni, uncooked
- 4 tbsp. flour
- 2 tbsp. fat
- ¼ tsp. dry mustard
- ½ tsp. salt
- 1 c. cheese, grated
- 2 tbsp. wheat germ

TOPPING

- 2 tbsp. bread crumbs
- 2 tbsp. cheese, grated

1. Add onion to milk and scald in double boiler.
2. Cook macaroni in boiling salted water until tender. Drain. Rinse in cold water.
3. Cream fat, flour and seasonings together in a bowl. Add to milk. Cook and stir until thick and smooth.
4. Add grated cheese and wheat germ. Remove from heat.
5. Mix sauce and macaroni. Place in greased casserole, 1½ qt. size. Cover with topping.
6. Bake in moderate oven, 350°, 15-20 minutes until topping is browned.

Serves 6.

Vegetables

Baked Carrots or Beets

- 5 large carrots or beets, coarsely grated
- 1 tsp. salt
- f.g. pepper
- 2 tbsp. water

1. Mix ingredients in greased casserole, 1½ qt. size.
2. Bake, covered, in moderate oven, 350°, 30-40 minutes for carrots, 50 minutes for beets.

Serves 5.

Baked Parsnips

GRATED

- 4-5 parsnips, coarsely grated
- 1 tsp. salt
- 1 tbsp. lemon juice
- ½ tsp. sugar
- 2 tbsp. water

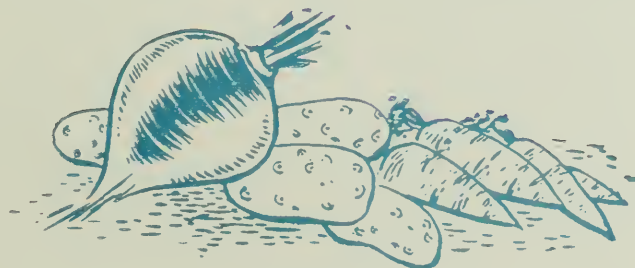
1. Mix ingredients in greased casserole, 1½ qt. size.
2. Bake, covered, in moderate oven, 350°, 30-40 minutes.

Serves 6.

QUARTERED

- parsnips, quartered
- salt
- f.g. pepper
- ¼ c. water

1. Mix ingredients in greased casserole, 1½ qt. size.
2. Bake, covered, in moderate oven, 350°, about 40-50 minutes.



Corn Soufflé

Serve as a supper dish or a vegetable.

- 1 c. scalded milk
- 3 tbsp. flour
- 2 tbsp. fat
- 1/2 tsp. salt
- f.g. pepper
- 3 eggs separated
- 1 1/2 c. corn (kernel or niblets)

NOTE: *This recipe may be used to make cheese, fish or other vegetable soufflés.*

1. Make thick white sauce. Cool. See method in Macaroni and Cheese, page 21.
2. Beat egg yolks well. Fold into white sauce, first adding a little of the sauce to the egg yolk and stirring thoroughly.
3. Add corn. Mix well.
4. Beat egg whites until stiff but not dry.
5. Fold sauce into beaten whites. Pour into greased casserole, 1 1/2 qt. size. Set casserole in a pan of hot water (oven-poach).
6. Bake, in moderate oven, 325°, 1-1 1/4 hours until knife put into centre comes out clean. Serve at once.

Serves 5-6.

Baked Stuffed Green Peppers

- 6 green peppers
- 1 tbsp. onion, diced
- 2 tbsp. parsley, chopped
- 1 c. soft bread crumbs
- 1/2 c. cheese, grated
- 1/2 tsp. salt
- 1/2 c. canned tomatoes
- fat

1. Cut a thin slice from stem end of peppers, or cut in half lengthwise. Remove seeds.
2. Boil, covered, in small amount of boiling water, 10 minutes.
3. Combine remaining ingredients.
4. Fill peppers with dressing. Dot with fat.
5. Bake in moderate oven, 375°, 25-30 minutes.

Serves 6.

Stuffed Onions

- 6 large onions
- 1/2 c. cooked ham, diced
- OR
- 1/2 c. green pepper, diced
- 1/2 c. soft bread crumbs
- 1/2 tsp. salt
- f.g. pepper
- 1/2 c. cheese, grated
- 1/4 c. water

1. Cut a slice from the top of each onion.
2. Boil, covered, in a small amount of boiling water, 20 minutes.
3. Drain, remove centres, dice. Add to ham, bread crumbs and seasonings.
4. Fill onion cups. Place in greased baking dish. Cover with cheese. Add water.
5. Bake in hot oven, 400°-450°, until tender, about 20 minutes.

Serves 6.

Baked Potatoes

1. Scrub and rinse potatoes of uniform size.
2. Grease skins lightly.
3. Bake at 375°-500° until tender, approximately 60 minutes for medium sized potatoes.

NOTE: Potatoes cooked at 425°-500° are more likely to be mealy than those cooked at a lower temperature.

Baked Tomatoes

6 tomatoes
salt
f.g. pepper
¼ c. crumbs
1 tbsp. cheese, grated

1. Cut tomatoes in half.
 2. Place in greased casserole, 1½ qt. size.
 3. Sprinkle with salt and pepper.
 4. Mix crumbs and cheese. Sprinkle on tomatoes.
 5. Bake, covered, in moderate oven, 350°, 20-30 minutes.
- Serves 6.

Salads and Salad Dressings

Tossed Vegetable Salads

Salads may be made of shredded or torn lettuce to which one or more of such fresh vegetables as the following are added:

shredded spinach	finely chopped onion	tomato wedges
onion rings	strips or rings of green pepper	diced or sliced cucumber
endive	shredded green or red cabbage	cress
bean sprouts	fine carrot sticks	pepper grass
diced celery	fine turnip sticks	sliced radishes

For good vegetable salads

1. Use garden fresh vegetables. As vegetables wilt, they lose flavour and food value.
2. Prepare fresh vegetables just before mealtime. Add dressing at once. French dressing is popular with fresh vegetable salads. Toss lightly. Serve. Here is a type of French Dressing.

French Dressing

3 onions, grated
½ c. sugar
1 c. catsup
1 c. vinegar
1 c. oil
1 tsp. dry mustard
1 tsp. salt
2 tsp. Worcestershire sauce

1. Measure ingredients into bottle with tightly fitted cover.
2. Shake well. Store in cold place.

"Salads — All the Year 'Round", a booklet with many recipes for salads and salad dressings may be obtained by writing to: Extension Branch, Home Economics Service, Ontario Department of Agriculture, 1207 Bay St., Toronto 5.



Flour Mixtures and Desserts

Pastry

- 2 c. sifted pasty flour
- OR
- 1 c. sifted pastry flour *and*
- 1 c. sifted whole wheat flour
- 1 tsp. salt
- $\frac{2}{3}$ c. cold fat
- about $\frac{1}{3}$ c. cold water

1. Sift flour and salt into mixing bowl.
2. Cut in two-thirds of fat, until particles are size of peas. Cut in remainder more coarsely.
3. Sprinkle water gradually over fat-flour mixture. Toss with a fork. Set aside small balls of dough as they form. Press balls together.
4. Roll lightly into circular sheet of uniform thickness.
5. Ease dough into pan. Do not stretch. For pie shell prick well.
6. Bake in very hot oven, 450° , 12-15 minutes, or until golden brown around edge.

Raisin and Orange Pie Filling

- 1 diced orange or lemon
- 1 lb. raisins
- $2\frac{1}{2}$ c. water
- 3 tbsp. sugar
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{2}$ tsp. nutmeg
- 2 tbsp. flour

1. Cut all rind from orange. Dice rind very finely.
2. Simmer rind, raisins and water, covered, about 10 minutes.
3. Mix dry ingredients and combine with fruit mixture.
4. Cook and stir until thick.
5. Add finely chopped orange pulp.
6. Heap cooled filling in baked pie shell. Serve with whipped cream or meringue. See recipe, page 25.

Meringue

- 2 egg whites
- $\frac{1}{8}$ tsp. salt
- $\frac{1}{2}$ tsp. vanilla
- 4 tbsp. fine sugar

1. Beat egg whites until frothy. Eggs at least 3 days old and at room temperature beat most successfully.
2. Add salt and vanilla and continue beating until eggs form a thick foam.
3. Add sugar, a tablespoon at a time, beating after each addition.
4. Continue beating until meringue stands in peaks when beater is raised out of mixture.
5. Spread a small amount of meringue around edge of filled pie shell, allowing no space between edge of pie shell and meringue. Pile rest of meringue in centre and spread lightly to meet this edge.
6. Bake in slow oven, 325° - 350° , about 15 minutes.

Tea Biscuits

- 2 c. sifted pastry flour
- OR
- 1 c. sifted pastry flour *and*
- 1 c. sifted whole wheat flour
- 4 tsp. baking powder
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{3}$ c. fat
- about $\frac{2}{3}$ c. milk

1. Sift dry ingredients into mixing bowl.
 2. Cut in fat.
 3. Pour milk into centre of flour mixture. Stir until mixture leaves sides of bowl.
 4. Knead gently on lightly floured board, 1 minute. Pat to 1" thickness. Cut.
 5. Bake on ungreased pan, in very hot oven, 450° - 500° , 10-12 minutes.
- Yields 10 biscuits, 2" in diameter.

Plum Roll

- recipe of Tea Biscuits (above)
- 1, 20 oz. tin red plums
- OR
- 1 pt. home canned red plums
- Canned rhubarb, cherries or blueberries can be used in this recipe.*

1. Roll dough $\frac{1}{4}$ " thick.
 2. Spread drained, pitted fruit over dough. Roll like a jelly roll.
 3. Bake whole on greased pan, or slice $1\frac{1}{2}$ " thick and bake in greased muffin tins, cut side up.
 4. Bake in hot oven, 400° , 30 minutes for roll; 15-20 minutes for slices.
- Serve hot with Fruit Sauce. See recipe, page 26.
- Serves 6-8.

Fruit Sauce

- 1 tbsp. cornstarch
- $\frac{1}{4}$ c. sugar
- grated rind of 1 lemon
- 1 c. syrup from canned fruit
- juice of 1 lemon

1. Mix cornstarch, sugar and grated rind.
2. Slowly add syrup. Stir. Cook and stir until sauce is thick and clear.
3. Serve hot, adding lemon juice just before serving.

Prune and Apricot Upside-down Cake

NOTE:

1. *The shortening, milk and eggs should be at room temperature.*
2. *Use an "emulsifier" type or "quick mix" type of shortening.*

- 1 c. dried apricots
- 12 prunes
- 2 tbsp. butter
- $\frac{1}{2}$ c. sugar
- $1\frac{3}{4}$ c. sifted pastry flour
- 1 c. sugar
- 1 tsp. salt
- 2 tsp. baking powder
- $\frac{1}{2}$ c. shortening
- $\frac{3}{4}$ c. milk
- 2 eggs
- 1 tsp. vanilla

1. Soak apricots and prunes in warm water about 30 minutes. Drain. Pit prunes while warm.
 2. Melt butter in 9" square pan. add sugar, heat slightly and blend. Arrange fruit in pan.
 3. Sift dry ingredients into bowl. Add shortening and half milk. Beat 2 minutes.
 4. Add remaining milk, unbeaten eggs and vanilla. Beat 2 minutes. Pour over fruit.
 5. Bake in moderate oven, 350° . about 35 minutes. Let stand 10 minutes, then invert on serving plate.
- Serves 9.

Rolled Oats Muffins

- 1 c. sifted pastry flour
- 4 tbsp. sugar
- 3 tsp. baking powder
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{2}$ c. raisins or chopped dates (optional)
- 1 c. quick-cooking rolled oats
- 3 tbsp. fat, melted
- 1 egg, beaten
- 1 c. milk

1. Grease 10 muffin tins.
2. Mix and sift flour, sugar, baking powder and salt.
3. Stir in fruit and rolled oats.
4. Add melted fat to egg and milk.
5. Add wet ingredients, all at one time, to dry ingredients. Mix only enough to dampen all flour. Work quickly.
6. Two-thirds fill muffin tins. Bake in hot oven, 425° , about 20 minutes. Serve warm.

NOTE: *See illustration on inside front cover.*

Cinnamon Topped Muffins

Use recipe of Rolled Oats Muffins (above).

Combine $\frac{1}{3}$ c. brown sugar, 2 tsp. cinnamon and 1 tbsp. melted butter. Sprinkle over muffins before baking.

Buttermilk or Sour Milk Muffins

Use recipe of Rolled Oats Muffins. See recipe, page 26.

Use 1 c. buttermilk in place of 1 c. sweet milk. Use only 2 tsp. baking powder. Add $\frac{1}{2}$ tsp. soda.

Wheat Germ Muffins

- $1\frac{2}{3}$ c. sifted pastry flour
- 5 tsp. baking powder
- 1 tsp. salt
- 3 tbsp. sugar
- $\frac{2}{3}$ c. wheat germ
- $\frac{1}{3}$ c. fat, melted
- 2 eggs, beaten
- 1 c. milk

1. Grease 12 muffin tins.
2. Sift flour, baking powder, salt and sugar into mixing bowl.
3. Stir in wheat germ.
4. Add melted fat to eggs and milk.
5. Add wet ingredients, all at one time, to dry ingredients. Mix only enough to dampen all flour. Work quickly.
6. Two-thirds fill muffin tins. Bake in hot oven, 400° , 15-20 minutes. Serve warm.

Rice Pudding

- $\frac{1}{3}$ c. uncooked rice
- 3 tbsp. sugar
- 4 c. milk
- $\frac{1}{2}$ tsp. salt
- $\frac{1}{2}$ tsp. cinnamon or nutmeg
- $\frac{1}{2}$ c. raisins (optional)

1. Wash rice thoroughly and place in a greased casserole, $1\frac{1}{2}$ qt. size.
2. Add other ingredients.
3. Bake in slow oven, 300° , $1\frac{1}{4}$ - $1\frac{1}{2}$ hours. Stir occasionally. The mixture should not boil.
4. Serve hot or cold. Serves 5-6.

Honey Custard

- 2 c. scalded milk
- 4 tbsp. honey
- $\frac{1}{4}$ tsp. salt
- 2 eggs or 4 yolks (if baked in individual servings)
- 3 eggs or 6 yolks (if baked in one large dish)

1. To scalded milk add honey and salt.
2. Add milk mixture to slightly beaten eggs.
3. Strain into baking dishes. Place baking dishes in pan and surround with hot water.
4. Bake in slow oven, 325° - 350° , until knife inserted carefully in middle of custard comes out clean. Approximate baking time: individual servings, 30 minutes; one large dish, 60 minutes.
5. Cool quickly. Serve cold. Serves 5.

NOTE: Most people prefer custard baked in individual servings.

Fruit Crisp

- 6 apples, sliced
- 1/2 c. brown sugar
- 1/2 c. whole wheat flour
- 1/2 tsp. nutmeg
- 1/8 tsp. salt
- 1/4 c. brown sugar
- 1/3 c. quick-cooking rolled oats
- 1/4 c. butter

1. Sprinkle brown sugar over apples in greased casserole, 1 1/2 qt. size.
2. Mix and sift flour, nutmeg, salt and brown sugar. Stir in rolled oats. Cut in butter, as in pastry making.
3. Spread flour mixture over apples.
4. Bake in moderate oven, 350°, about 50 minutes, or until crust is lightly browned. Serve plain or with cream.

Serves 5.

NOTE: This recipe may be adapted to other fruit such as rhubarb, peaches or tart plums.

Baked Rhubarb

- 3 c. diced rhubarb (about 6 large stalks)
- 1 c. sugar
- grated rind of 1 orange
- 2 tbsp. water

1. Mix ingredients in casserole, 1 1/2 qt. size.
2. Bake, covered, in moderate oven, 350°, 20-40 minutes.
3. Serve cold.

Serves 5.

Baked Prunes

1. Wash fruit. Soak until prunes are plump, in casserole in enough water to cover. If hot water is used, time needed for soaking can be reduced. Cover casserole.
2. Bake in moderate oven, 350°, about 50 minutes.
3. To 1/2 lb. prunes, add 3 tbsp. sugar. Stir. If desired, juice of 1/2 lemon may also be added.

1/2 lb. prunes serves 7-8.

NOTE: This method may be adapted to other dried fruits.



BULLETIN 519

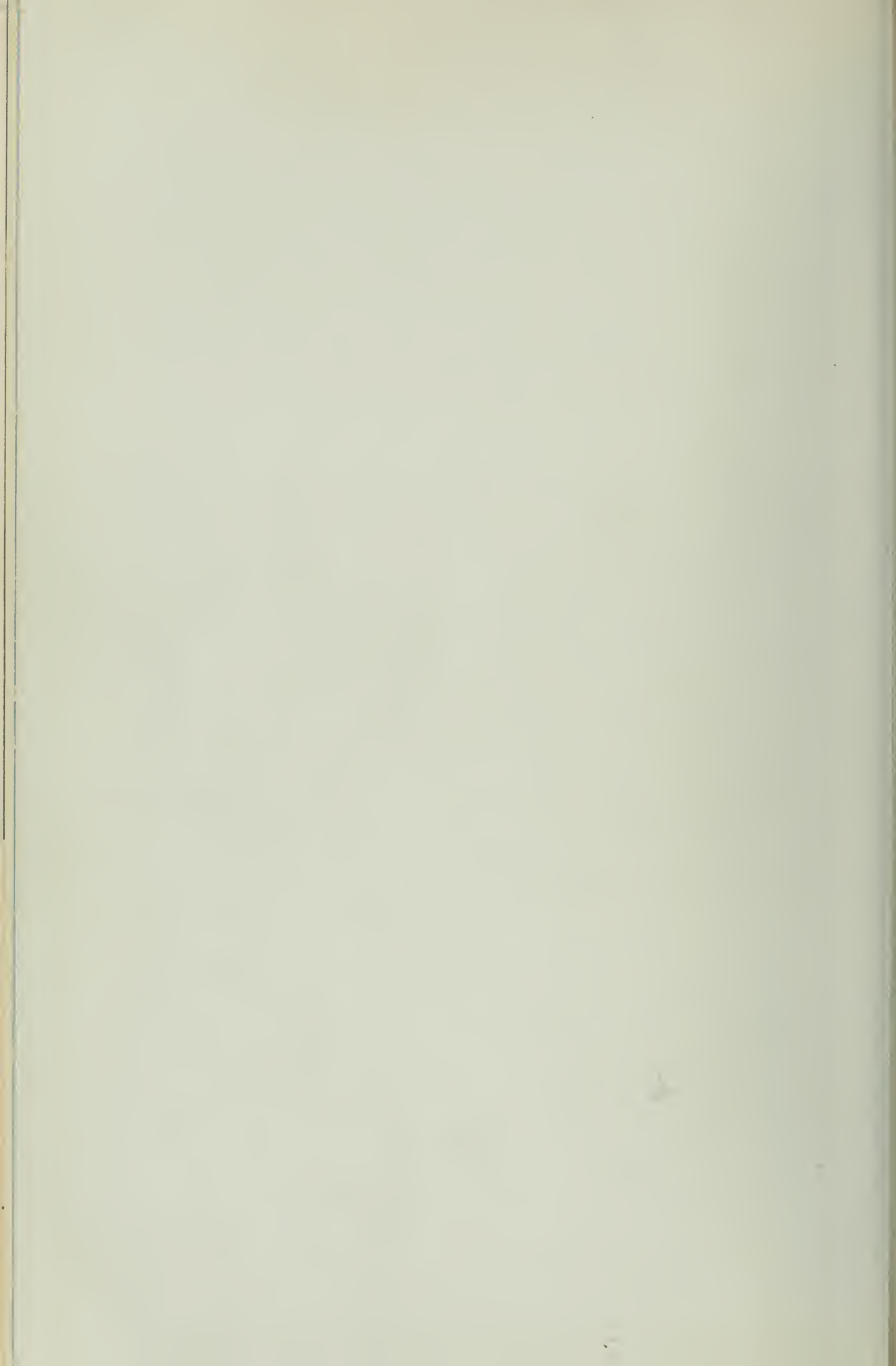
CARONAF6
B519

APRIL, 1957

DAIRY HUSBANDRY IN ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA



CONTENTS

FOREWORD	4
STATUS OF DAIRYING IN ONTARIO	5
UTILIZATION OF WHOLE MILK IN ONTARIO	5
MILK MARKETING LEGISLATION	6
ESTABLISHING AND IMPROVING A DAIRY HERD	7
HERD FEEDING AND MANAGEMENT	12
NUTRIENT REQUIREMENTS OF DAIRY CATTLE	12
CHARACTERISTICS OF FEEDS	19
GRAINS, BY-PRODUCTS AND CONCENTRATES	19
ROUGHAGES	20
COMPOSITION OF FEEDS	23
RULES FOR FEEDING DAIRY COWS	27
STABLE FEEDING	30
SUMMER FEEDING	31
AMOUNT OF CONCENTRATES TO FEED ON PASTURES	32
FEEDING THE COW DURING THE DRY PERIOD	35
FORMULA FOR DRY AND FITTING GRAIN MIXTURE	36
FEEDING AND CARE OF THE CALF	37
FEEDING AND MANAGEMENT OF THE BULL	44
MILKING PROCEDURE	46
HERD HEALTH	47
HOUSING THE DAIRY HERD	59
PLANNING THE STALL BARN	60
PLANNING THE LOOSE HOUSING SYSTEM	64

DAIRY HUSBANDRY IN ONTARIO

This bulletin was prepared by a Committee consisting of:

PROF. G. E. RAITHEY, Department of Animal Husbandry, Ontario Agricultural College, Guelph;

W. P. WATSON, Live Stock Commissioner, Ontario Department of Agriculture;

DR. H. D. BRANION, Professor and Head of Department of Nutrition, Ontario Agricultural College, Guelph;

PROF. C. G. E. DOWNING, Head of Department of Agricultural Engineering, Ontario Agricultural College, Guelph;

MR. A. M. BARR, Principal, Kemptville Agricultural School, Kemptville, Ontario;

DR. J. A. HENDERSON, Professor and Head of Clinical Division, Ontario Veterinary College, Guelph.

FOREWORD

Because of the contribution which she has made to the health and physical well-being of mankind the dairy cow has frequently been described as the foster mother of the human race. This docile creature whose cud-chewing habits seem to brand her as a model of simplicity is indeed a very complex machine, one that is capable of consuming raw material of low quality and by some mysterious process of converting it into nature's finest and most nutritious food.

Although the dairy cow has contributed much to the health of mankind, she has also helped to enhance the financial status of those who have adopted her as the medium through which their primary farm products are marketed. Even so, she does not respond equally when subjected to all types of conditions; rather she produces most abundantly when given proper nourishment, adequate housing, reasonable care and capable attention when attacked by pests or disease. Such being the case this bulletin is being published for the purpose of providing persons interested in dairy husbandry with information which should, if applied, point the way to a more profitable dairy enterprise.

DAIRY HUSBANDRY IN ONTARIO

STATUS OF DAIRYING IN ONTARIO

In 1955, the farm cash income derived from the sale of Ontario's dairy products amounted to \$145,227,000. This figure was exceeded by only one class of farm product, namely cattle and calves. However over 30 per cent of the cattle and at least 75 per cent of the calves sold for slaughter during the year were of dairy origin.

Moreover there were other sources of revenue — a great many cattle of the class normally classified as surplus breeding stock were sold in the domestic market to persons establishing new herds or wishing to increase the sizes of their herds. Although statistical information with regard to such sales is not available it is a well known fact that they are quite substantial.

But Ontario cattle sales are not confined to the domestic market. In 1955, Canadian exports included 20,481 head of dairy cattle and 21,210 head of pure bred cattle, the majority of which were of dairy breeding. Of these totals well over 75 per cent originated in Ontario.

Thus when returns from the sale of dairy cattle are added to the revenue derived from the sale of dairy products it becomes obvious that the dairy industry is the most important Branch of Ontario Agriculture.

Utilization of the Whole Milk in Ontario

Although the sale of cattle for slaughter and of surplus breeding stock, both at home and abroad, make a substantial contribution to the income of Ontario's dairy farmers the greater part of their revenue is derived from the sale of milk and its products. Notwithstanding this fact there has been little change in the quantity of milk produced in recent years. In 1941, Ontario's production was 5.54 billion pounds as compared with 5.52 billion pounds in 1955. During that 14-year period production ranged from a low of 5.05 billion pounds in 1951 to a high of 5.71 billion pounds in 1945.

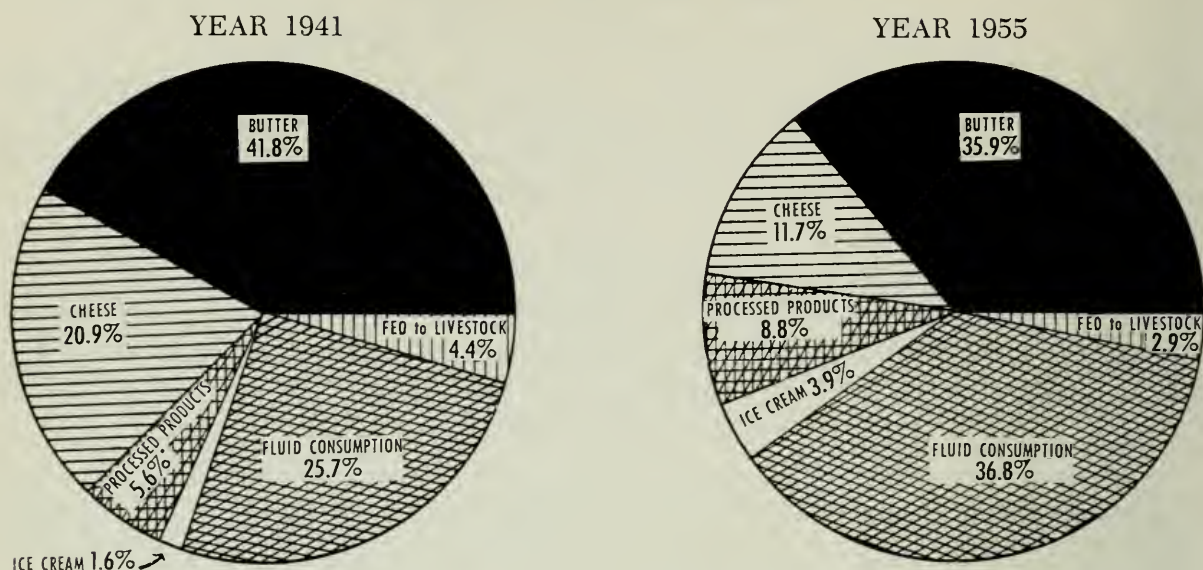
While milk production remained fairly constant Ontario's human population increased at a record rate, mounting from a modest 3,788,000 in 1941 to an imposing 5,183,000 in 1955. A high percentage of these new citizens were native born, hence are still at the age when milk should constitute the most important item in their diets.

Canada's northland figured prominently in the expansion which took place during that period. New mines were brought into production, lumbering activities were extended, and homes were built to house the new citizens attracted to the north country. These populated areas, many of which are far removed from farming communities, must obtain milk in a form that will permit storing for long periods of time. Hence their needs have contributed to the significant increase in the domestic market for concentrated and powdered milk products.

Obviously the demand for increased quantities of fluid milk and concentrated milk products could not be met during a period when the overall production of milk remained fairly constant unless some producers switched from one market to another. Thus as fluid and concentrated sales increased, production of butter and cheese declined, a trend which is likely to continue as long as Canada's population keeps on growing and as new frontiers are being explored.

The change in the utilization of our milk supplies is graphically shown in the following chart.

PERCENTAGE UTILIZATION OF WHOLE MILK IN ONTARIO YEARS 1941 AND 1955



For the most part fluid milk is being produced within a reasonable distance of the cities, towns or villages in which it is consumed. In the case of large urban centres such as Metropolitan Toronto supplies are drawn from farther afield. Generally speaking, however, the majority of dairymen located near urban municipalities are engaged in the production of fluid milk, while producers not so fortunately situated are obliged to seek other outlets.

The largest butter producing counties are located in Western Ontario, the leaders in that field in 1955 being Perth, Bruce, Grey, Wellington, Renfrew, Waterloo, Simcoe and Hastings, in that order. On the other hand Eastern Ontario has a monopoly on cheese production, the leaders being Leeds, Stormont, Dundas, Russell, Glengarry, Prescott, Hastings and Lennox, each of which produced over three million pounds in 1955.

Milk Marketing Legislation

In Ontario, the minimum price for fluid milk, processed milk and cheese is established by negotiations. Authority for the negotiations is contained in the Milk Industry Act. Under its provisions two Boards, each with certain regulatory powers, have been established. The Milk Board deals with matters pertaining to the marketing of fluid milk, while the activities of the Milk Products Board centre around the marketing of milk for processing and milk for use in the manufacture of cheese.

Regardless of the use for which the milk is intended the same general procedure is followed in establishing minimum prices. Committees comprised of representatives of the producers and an equal number of representatives of the distributors, processors or cheese trade, as the case may be, consider all the facts and endeavour to arrive at a minimum price that is acceptable to both parties. In the event that negotiations break down the points in contention are settled by arbitration. Once a minimum price has been established no person may purchase milk at a lower figure. However for all practical purposes fluid milk distributors and processors of manufactured milk reserve the right to determine the quantity that they will purchase.

In the case of cheese each individual buyer determines the quantity that he will purchase and the price that he will pay, subject to the minimum price provisions. If the quantity offered is in excess of that which the regular trade will buy it becomes necessary for some other person or organization to purchase the

surplus. During recent years the Ontario Cheese Producer's Marketing Board has assumed ownership of any cheese that could not be sold to the trade at the minimum price on the day that it was offered. As a general rule this cheese was placed in storage for re-sale at a later date. In some cases it was sold in the domestic market at prices which would cover the cost plus handling charges, while at other times it was sold for export, presumably at prices which did not yield a full return on the investment. In such cases the loss was charged to a fund which was created by the deduction of a licence fee on all cheese sold.

Butter is one of the few commodities for which a floor price has been established under the Agricultural Price Support Act. In view of the fact that this commodity is produced in all provinces, and is the basic dairy product in most of them, the Government of Canada has seen fit to establish a floor or minimum price, which is currently 58 cents per pound in Ontario. In order to make the program operate successfully the Agricultural Prices Support Board has been authorized to purchase all butter offered at the floor price. Thus any other person must pay at least that amount. Because of the large volume of milk that is utilized in the manufacture of butter the support given to this commodity has created a great deal of stability to the dairy industry; in effect it has meant that no dairy product need sell at a price lower than the equivalent of the floor for butter.

Breeds of Dairy Cattle

Generally speaking, there are four recognized breeds of dairy cattle in Ontario. Although the actual population of each is not known, figures covering annual registrations provide a fairly reliable indication of their relative numbers. In 1955, registrations for the four dairy breeds were as follows:

Breed	No. Registered	
	Ontario	Canada
Holsteins	57,373	73,400
Jerseys	7,568	12,675
Ayrshires	4,850	11,542
Guernseys	3,064	4,424

In addition to the "straight" dairy breeds there are two dual purpose breeds. These cattle presumably possess the ability to produce offspring which conform to a type usually associated with beef cattle as well as being able to produce reasonably large quantities of milk. These breeds, the Dual Purpose Shorthorns and the Red Polls, are not as strong numerically as the dairy breeds.

It is not the intention of the authors of this bulletin to indulge in any discussion regarding the merits of these breeds. Suffice it to say that each has demonstrated that it can make a contribution to our dairy industry, otherwise its numbers would have declined, a situation which has not developed. Nevertheless, aside from personal preference, every individual planning to establish a dairy herd should consider such factors as the milk markets available and the prospects for selling surplus breeding stock before finally deciding upon a breed.

Milk Recording Systems

Even within breeds, dairy cows vary greatly in their ability to produce milk and butter fat. Of course, some of the variation is due to the manner in which they are fed. However some of it is inherited, and variation due to this cause cannot be corrected by feeding.

Under the circumstances every dairyman should adopt some method of measuring each cow's performance. If a dairyman is not concerned about the butter fat content of his milk, he can develop his own system by simply weighing the quantity of milk produced by each cow at each milking. However, most dairymen are interested in the test as well as the quantity. Such persons can obtain



A HOLSTEIN COW

This picture illustrates Holstein characteristics and dairy type. The head is stylish, clean-cut and alert, the shoulder blends smoothly into the body, which is deep and capacious. The back and loin are straight and strong, the rump level, and the tail head reasonably smooth. The udder is capacious, well attached fore and rear, and prominent veins are shown on the udder and body. The legs are well shaped with good quality bone.

assistance in achieving their objectives as a result of policies sponsored by the two Departments of Agriculture.

(a) Record of Performance

The Record of Performance, or R.O.P. as it is commonly called, is sponsored by the Canada Department of Agriculture for the purpose of providing a milk testing service in pure-bred herds. Breeders have the option of two plans, one involving daily weighing by the owner with periodical checks by an inspector, the other based on weights taken by an inspector on one day each month. In either case samples taken by the inspector are used in determining the butter fat content of the milk. Official records are based on 305 or 365 day lactations, depending upon the length of time that the cow milks and the type of record desired by the owner. The Canadian Holstein Friesian Association restricts the registration of bull calves to the progeny of cows with official records, both from the standpoint of production and type. Breeders wishing further particulars with regard to this policy should contact the Supervisor of R.O.P., Canada Department of Agriculture, Ottawa.

(b) Dairy Herd Improvement Association

This program, sponsored by the Ontario Live Stock Branch of the Ontario Department of Agriculture, was initiated to supplement the R.O.P. not to compete with it. As a consequence participation is restricted to the owners of grade herds or herds comprised of both pure-breds and grades. Applicants for enrolment are grouped into associations, each comprised of 22 - 24 members. The supervisor assigned to each association calls on each member one day per month. While there



AN AYRSHIRE COW

This mature cow shows strength, constitution, capacity, well developed mammary system, and throughout dairy quality, indicating producing ability. This picture was taken when the cow was eleven years old, and she therefore shows a maturity that is not shown in pictures of cows taken at an earlier age. Wearing qualities and longevity are desirable traits of any cow and are outstanding characteristics of this cow. Somewhat less throatiness, less hook on the hind legs, and a little smoother tail set would improve this cow.

he weighs the production of each cow at each milking, takes a sample from each milking and tests the composite samples. This information is forwarded to the Live Stock Branch office where it is used for computing lactation records. These records are based on a 305-day lactation or until the cow goes dry, whichever occurs first.

In addition to a milk recording service members are provided with information pertaining to cost of production. These data are compiled by the Farm Economics Branch from information collected by the D.H.I.A. supervisors. Dairy-men interested in the D.H.I.A. testing program should contact the Ontario Live Stock Branch, Parliament Buildings, Toronto.

Selective Registration or Type Classification

Although most dairymen derive the greater part of their income from the sale of milk, those who are interested in supplementing their returns by selling surplus breeding stock are conscious of the fact that the average buyer prefers a good looking animal, while the discriminating buyer places a great deal of stress on appearance.

Equally aware of this situation are the breed associations, each of which has been sponsoring a selective registration policy for some years. While there may be slight differences in the policies of the respective associations their objectives are similar, to wit, to encourage breeders to have their individual animals classified from the standpoint of their type and conformation, which in the case of females includes an appraisal of their mammary development. Six grades have been established namely: excellent, very good, good plus, good, fair



A JERSEY COW

This picture shows a Jersey cow with exceptional refinement and character in the head and a smoothly laid in shoulder with great width across the chest floor. Capacity is indicated by the good spring of rib and body depth. The udder carries up well in the rear and is well developed in the front quarters that are firmly attached. The hind quarter is very long, but might show more smoothness on top, particularly in front of the tail head.

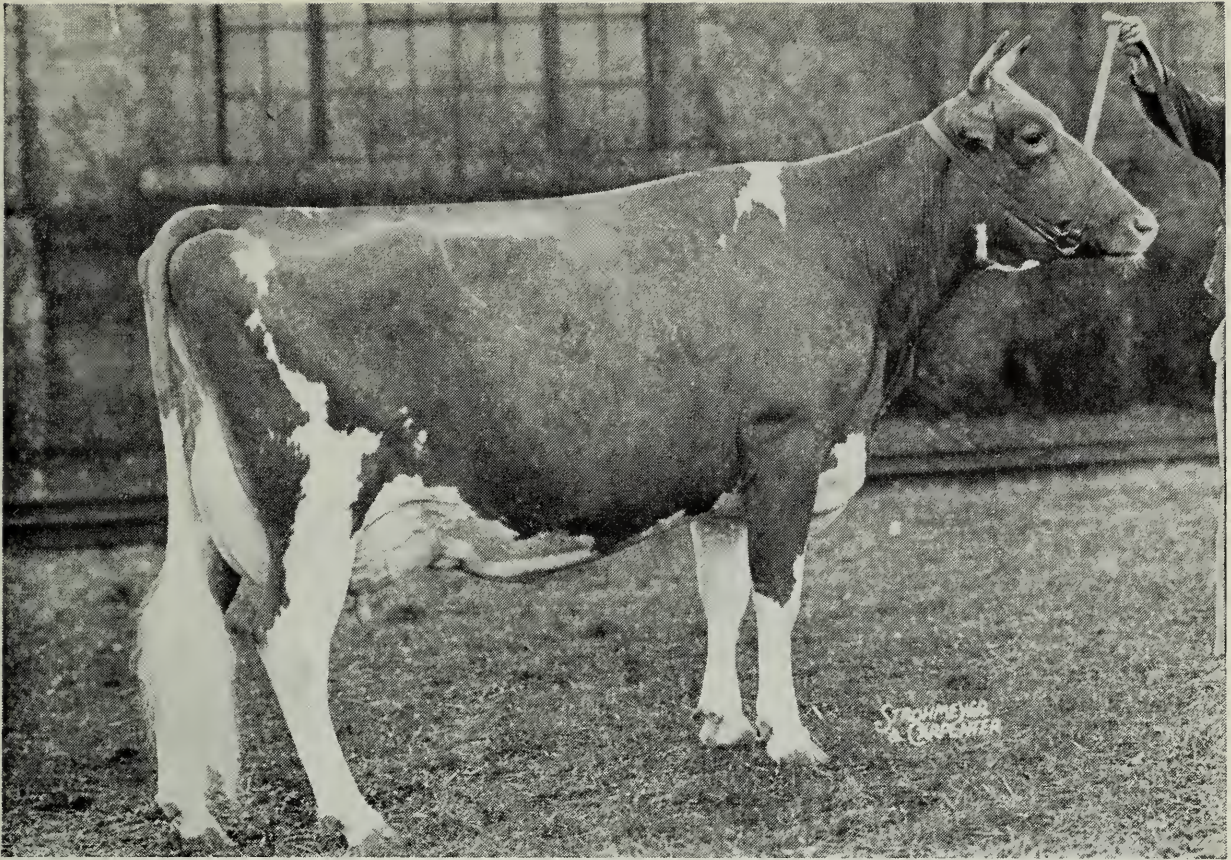
and poor and a standard scale of points has been prescribed for each grade.

These policies are sponsored and administered by the Breed Associations. Consequently breeders interested in obtaining more information about herd classification should contact the secretary of the breed concerned.

Artificial Insemination

Milk production, fat production and breed type, characteristics of great economic significance to every dairyman, are heritable to a moderate degree. Consequently cows that have the inherent ability to produce large quantities of milk, or milk having a high butter fat content, or cows of good type are presumed to be able to transmit these characteristics to their offspring. It naturally follows that cows which are deficient in any of these respects can pass their weaknesses along to their progeny as well. Under the circumstances the adoption of a sound breeding program is the basis of dairy cattle improvement. If the potential for higher milk or fat production is increased by better breeding it should be possible to attain the goal of more efficient production, particularly if feeding practices are improved too. Thus the sire is the keystone to herd improvement. He is the father of every calf, so he controls the destiny of the future herd replacements.

Artificial insemination which was first practiced in this province in the early 1940's provides a method whereby the use of good sires can be extended to a great many herds and to the herds of persons who did not feel that they were financially able to purchase outstanding bulls. Since the first Artificial Insemination centre was organized in 1945 the program has developed at a rapid rate; within five years nine centres, each of which maintained bull studs, were in operation. By co-operating with one another in the exchange of semen from bulls of certain



A GUERNSEY COW

A Guernsey cow showing the characteristics of this breed and outstanding dairy temperament wanted in a cow of any dairy breed. A former champion at major shows, she has a very smoothly laid in shoulder, a great constitution and body capacity. The quarter is well nigh perfect. It is long, wide at the pins, high in the thurl region, with no excess fattiness. The legs are of excellent quality and well shaped. The mammary system is almost beyond criticism, with a well attached, outstanding udder and body veins. There is no quartering and the teats are of correct shape and length, and throughout it shows quality and texture. Perfection is hard to attain and this cow might be criticized for a little plainness of head and flatness of loin.

breeds it has become possible for each centre to offer a comprehensive service for all breeds common to district, even though bulls of several breeds are not maintained at the centre. Semen is being sold to sub-centres in the districts of Northern Ontario. Within the decade following the establishment of the first centre the use of artificial insemination has grown to the point where over 315,000 cows were serviced in 1955 and approximately one-third of all dairymen are depending on A.I. centres to select their herd sires.

Management, on the other hand, is eager to furnish customers with the best possible service. Hence bulls are carefully selected — sometimes on the basis of their performance in private herds, but more frequently on their potentialities. In the latter cases bulls are used sparingly until the performance of their daughters is known. Then those that come up to expectation are put into heavy service while the ones with disappointing records are discarded.

The advent of frozen semen has greatly extended the usefulness of the top sires. Whereas previously the semen collected from them had to be used within a relatively short period of time it is now possible to preserve and maintain it in a frozen state for an indefinite period — possibly for years. Thus semen can be collected at regular intervals and stored until needed. Dairymen will no longer be obliged to use the liquid semen that is available on the day that the cow is in season, but may order semen from a bull of their own choosing.



This picture shows a Dual Purpose Shorthorn combining beef type and milking qualities to a high degree. The cow is thickly fleshed and has size without coarseness. The udder shows quality with a nice blending into body. The teats are a convenient size and shape.

HERD FEEDING AND MANAGEMENT

The managerial ability of the dairyman may mean the difference between success or failure in the operation of a dairy farm. It involves the investment of capital, the management of labour and the soil, crops and the herd, the maintenance of herd health, the marketing problems of both milk and cattle and a flexibility of judgment to adjust the whole operation to the changing conditions of weather, season, markets and acts of nature.

One of the essential functions of dairying is to convert feeds, otherwise often unmarketable, into an edible marketable product. These feeds involve roughages and concentrates, home grown grains and purchased grains, by-products and mixed supplements and pasture of both permanent and temporary type. The preparation of suitable, economical rations becomes therefore one of the major activities of the dairyman.

NUTRIENT REQUIREMENTS OF DAIRY CATTLE

Feeds must supply carbohydrates, protein, fat and certain vitamins and minerals. The requirements of the herd for each item must be kept in mind in feeding dairy stock of different ages and at various levels of production.

Energy which is obtainable from the carbohydrates, proteins and fats in feedstuffs is required in large amounts for growth, lactation and reproduction, as well as the obvious requirements for physical activity and for keeping the body warm. In young animals insufficient energy supplies will result in poor and uneconomical weight gains. For satisfactory reproduction there must be adequate energy intake, and heavy lactation demands an even greater intake.

Carbohydrates

The most plentiful and economical source of energy for cattle is the carbohydrate portion of the feed, including both the nitrogen-free extract (starches, sugars) and the fibre (cellulose) fractions. The action of the micro-organisms in the rumen enables cattle and other cud-chewing animals to digest much of the fibre consumed. The feeds high in fibre are known as "roughages", and this class includes pastures, hays and silages, as well as corn fodder, stover, corn cobs, and hulls of grains and other seeds. Feeds, such as grains, which are high in sugars and starches but low in fibre are known as energy "concentrates".

The term Total Digestible Nutrients (T.D.N.), used to express the energy value of a feed, includes all the digestible carbohydrates, protein and fat (the last being multiplied by $2\frac{1}{4}$ since it has a higher energy value than the others). The higher the T.D.N. value, the higher the energy content of a feed.

Proteins

Proteins are complex nutrients containing nitrogen in a special combination. They are absolutely essential to life in all animals, for the formation of muscles, organs, bones, milk and certain other body compounds. The requirement is greatest during periods of rapid growth, reproduction and lactation.

If the growing animal is not provided with enough protein to meet the heavy demands for new tissue, growth will be slowed down. Early and rapid gains are usually the most economical, and sufficient protein to permit this type of growth should be made available. It is well to bear in mind, however, that protein is usually the most expensive nutrient item, and the feeding of more than required is rarely economical. In pregnancy the cow requires additional protein to build the body of her calf, and in lactation the requirement is even greater to provide the large amount of protein in the milk.

Some animal species (e.g. poultry and swine) are very exacting in their requirement for specific "high quality" proteins. Fortunately, protein quality is not a problem with cattle. The bacteria in the rumen are able to manufacture good quality protein for the cow from poor quality protein in the feed, and, to some extent, from certain other nitrogen-containing substances which are not proteins. For example, the chemical substance urea can be used to replace a limited portion of the protein in cattle rations. Practically the only consideration in protein-carrying feeds for cattle is the digestibility of the protein contained, the proportion of the protein which is digestible varying from one feed to another.

Fat

Not all the fat in milk comes from fat in the feed, much of it being made from the carbohydrate portion. Nevertheless, the amount of fat in the ration does have an influence upon health and production. The concentrate portion of the ration should contain a minimum of 3.0 per cent fat. While not a common problem, excessive amounts of fat (over 6%) in the ration may cause digestive upsets and scouring.

Vitamins

Vitamins are a special class of nutrients required by animals in amounts which are very small in comparison with carbohydrates and proteins. Nevertheless, their presence in such amounts is essential for good health and production. The many vitamins required have individual functions to perform but, in general, they can be described as regulators of body processes.

Only two vitamins, A and D, require special attention in cattle feeding. The rumen bacteria manufacture vitamin K and all the vitamins of the B group, and thus an outside source of these is not required after the first two months of life. Prior to this, the calf obtains these vitamins from milk. There is no evidence that supplements of vitamin E are required by dairy cattle on usual rations.

Vitamin A

Vitamin A is obtained from the feed in the form of carotene, a yellow coloring material which the animal changes into colorless vitamin A within its body. Some of the vitamin A, the surplus over the cow's requirement for its own body activities, is stored in the liver and the body fat and secreted in the milk. Variable amounts of unchanged carotene also occur in these places, giving the yellow color to body fat and milk fat.

This vitamin is required for growth, for vision, for the maintenance of healthy conditions in the tissues of the digestive tract, the respiratory organs and the eyes, and for successful reproduction and lactation. Shortages of vitamin A will cause poor growth, and extreme deficiencies will lead to night blindness, sore eyes, staggering, poor muscular control, and reproductive troubles. More common than marked shortages are slight or borderline deficiencies causing lowered performance in growth, lactation and reproduction.

The common source of carotene for cattle is green plant material. It is found abundantly in fresh pasture, and the younger and leafier the growth, the higher the carotene content. Under similar conditions clovers and alfalfa are better sources than grasses.

Dried-up pasture-growth is very low in carotene and sun-cured hay contains less than the freshly cut crop since exposure of the drying plant material to sunshine and air readily destroys carotene. The newer methods for the barn-drying of hay usually yield hay much higher in carotene than field-curing, since long exposure to sunlight is avoided. A gradual destruction of carotene occurs in hay during storage in the mow. When carefully done, the making of silage from pasture and hay crops will preserve good amounts of the carotene in the crops. The green color of hays and silages can be used as a rough guide to their value as carotene sources, although the green color itself is not carotene. Carotene is found also in yellow corn, and the feeding of corn grain or corn and cob meal will, therefore, make a contribution to the vitamin A nutrition.

The ability of cattle to store some of the vitamin A surplus during periods of excess intake from excellent pasture is very valuable in assisting them through periods of low carotene intake, such as drought periods or later winter.

Supplementary vitamin A may be supplied to calves by dry or oily preparations. Fish liver oils, especially those of low potency, should not be used as supplements for milking cows.

Vitamin D

Growing animals require vitamin D for the formation of strong bones and teeth, and adult animals require it for maintaining these structures. The minerals calcium and phosphorus, which form the major portion of hard bone structure, are not used and deposited properly in the absence of adequate vitamin D. A deficiency of vitamin D results in the condition of rickets in calves, the symptoms include swollen joints, lameness, and in later stages, decreased growth, dragging of hind feet and bending or even fractures in bones.

Vitamin D is obtained ordinarily by cattle in two ways: through exposure to sunlight which forms the vitamin in the body, and through the feed. Sun-cured plant material contains vitamin D produced through the action of the sun's rays. It should be noted that methods of hay-drying which avoid exposure to sunlight result in higher carotene retention, but, at the same time, prevent the formation of vitamin D in the hay. Similarly, forage preserved as silage contains little or no vitamin D.

Calves, especially those kept indoors, may require a vitamin D addition in the form of fish liver oil or a dry D supplement mixed with the concentrate.

Minerals

Of the numerous minerals known to be essential for dairy cattle many are present in the usual feeds in ample amounts, and usually only calcium, phosphorus, salt (sodium chloride), iodine and cobalt require special attention. The use of supplements to supply minerals other than these cannot be recommended at present for general use in Ontario despite the possibility that deficiencies in some other trace minerals may occur in certain regions which are not well defined as yet.

Calcium and Phosphorus

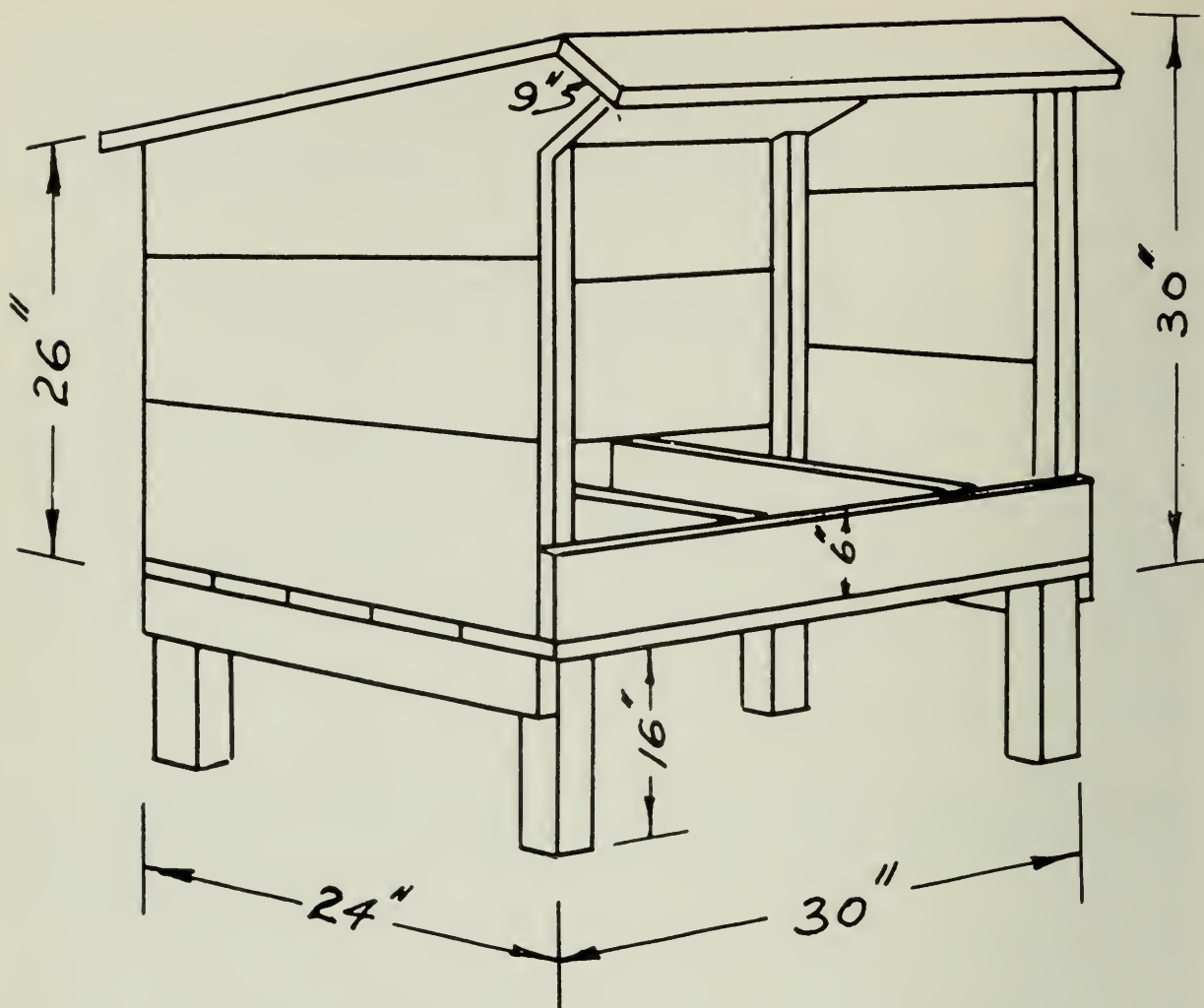
Calcium and phosphorus are discussed together since their utilization in the body is related, and in some of the supplementary sources they occur together. These two are the main mineral constituents of bones and teeth, and the demand for them is very great during growth and pregnancy to permit the manufacture of new bony structures. Since milk is very rich in both calcium and phosphorus, considerable additional supplies are required during lactation.

Insufficient supplies of either or both of these minerals will cause defects in bones resembling those described for vitamin D deficiency. Serious phosphorus shortages in rations give rise to some other symptoms such as a decrease in appetite, and as the deficiency progresses, a "depraved" appetite shown by a desire to chew bones, wood, dirt, etc.

Many Ontario soils are deficient in phosphorus, and feeds grown thereon are correspondingly low in this mineral. Cattle rations, therefore, most frequently show greater deficiency in phosphorus than in calcium. Forages are poor sources of phosphorus, grains and seeds are better. The latter are low in calcium, whereas forages are better but variable, legumes being much richer in calcium than are grasses. Young calves receive much calcium and phosphorus from milk.

Deficiencies of calcium and phosphorus are overcome by supplemental feeding of bone meal, dicalcium phosphate, monocalcium phosphate and *defluorinated* rock phosphates. Disodium phosphate supplies phosphorus only, whereas limestone provides calcium only. Various trade names are applied to these products by manufacturers. The amounts and proportions of the supplements to be fed depend somewhat upon the other ration ingredients, especially the nature of the roughage. The best procedure is to blend the supplements with salt and to mix a definite proportion with the home-mixed concentrate and in addition to allow the animals free access to the mineral mixture in a separate covered box.

Most commercial mixed concentrates contain supplementary minerals and it is not necessary to mix in any additional mineral. When feeding these concentrates, however, it is still wise to allow the animals free access to a mineral mixture.



A simply constructed weather protected salt and mineral box.

Salt, Iodine, Cobalt

Common salt (sodium chloride) serves many functions. It aids in milk production and serves to improve the palatability of the ration and to stimulate the appetite.

Iodine, although required in very small amounts, is a very vital mineral, essential for the activity of the thyroid gland which is the master control for all body processes. Deficiency of iodine is indicated when calves are born with goitre or "thick neck". A supplement is recommended for Ontario feeding conditions, and the most convenient and satisfactory supplement is iodized salt.

Within recent years it has been found that crops in some areas of Ontario are low in the mineral cobalt, and cattle feeding on them may not receive enough of this mineral unless a supplement is fed. A deficiency leads to unthrifty, listless animals which show gradual loss of appetite, weight loss, rough coats and anaemia. A depraved appetite similar to that of phosphorus deficiency may develop, and reproductive troubles may be encountered.

The small amount of supplementary cobalt required can be supplied best in the form of cobaltized salt. Its use is recommended for all Ontario dairy cattle.

The iodized and cobaltized salt may be mixed with concentrates or placed in a covered box in the yard or pasture field with the other minerals.

Mineral Supplements and Mixtures

Various combinations of the suggested calcium and phosphorus supplements and salt may be used to meet particular needs. Some suggested mixtures are given below:

- A. 50 pounds steamed Bone Meal, 25 pounds Disodium Phosphate, 25 pounds Iodized Cobaltized Salt.
- B. 50 pounds Feeding Bone Meal, 25 pounds Monocalcium Phosphate, 25 pounds Iodized Cobaltized Salt.
- C. 50 pounds *Defluorinated* Rock Phosphate, 25 pounds Disodium Phosphate, 25 pounds Iodized Cobaltized Salt.
- D. 50 pounds Monocalcium Phosphate, 17 pounds Ground Limestone, 33 pounds Iodized Cobaltized Salt.
- E. 67 pounds Feeding Bone Meal, 33 pounds Iodized Cobaltized Salt.

It should be borne in mind that the color of salt blocks containing iodine (red-brown) and cobalt (blue or purple) is due to added coloring substances and not to the trace minerals themselves. The fact that iodized and cobaltized loose salt may not be colored does not make it inferior nutritionally.

Various other combinations of available supplements may be used with satisfactory results. In table number 2 are given average figures for the calcium and phosphorus contents of the common supplements and for the mixtures suggested above.

TABLE NO. 2

	Calcium		Phosphorus	
	%	Grams per lb.	%	Grams per lb.
Supplements				
Bone Meal (Feeding)	25.0	113.5	10.9	49.5
Bone Meal (Steamed)	29.1	132.1	14.3	64.9
Dicalcium Phosphate	26.5	120.3	20.5	93.1
Disodium Phosphate	—	—	8.6	39.0
Limestone (Calcite)	38.3	173.9	—	—
Monocalcium Phosphate	16.0	72.6	24.0	109.0
Phosphate with Colloidal Clay	20.0	90.8	10.0	45.4
Rock Phosphate (<i>Defluorinated</i>)	27.0	122.6	13.4	60.8
Mixtures				
A	14.6	66.4	9.3	42.2
B	16.5	75.0	11.45	52.0
C	13.5	61.3	8.9	40.4
D	14.5	65.9	12.0	54.6
E	16.8	76.3	7.3	33.2

Feeding Standards

Studies of cattle feeding by many investigators in many locations have made it possible to recommend actual amounts of the individual nutrients which should be provided for animals of various sizes and ages and at different stages of production. All animals do not have exactly the same requirements even under similar circumstances, and usually the amounts recommended are near the maximum requirement. Recommendations have been presented in different forms by different investigators and groups, usually under the names of "Feeding Standards" or "Recommended Allowances". Tables 3 and 4 present, in part, Morrison's Feeding Standards for Dairy Cattle (1956 edition).

TABLE NO. 3. MORRISON FEEDING STANDARDS (22ND EDITION).

	Digestible Protein*	Total Digestible Nutrients*	Calcium		Phosphorus		Carotene
	Lbs.	Lbs.	Grams	Lb.	Grams	Lb.	Mg.
1. Dairy cows							
A. For maintenance, per head daily							
800-lb. cow	.49-.54	5.8- 6.5	8.0	.018	8.0	.018	48
900 lb. cow	.55-.59	6.4- 7.2	9.0	.020	9.0	.020	54
1,000-lb. cow	.60-.65	7.0- 7.9	10.0	.022	10.0	.022	60
1,100-lb. cow	.65-.71	7.6- 8.6	11.0	.024	11.0	.024	66
1,200-lb. cow	.70-.76	8.2- 9.3	12.0	.026	12.0	.026	72
1,300-lb. cow	.75-.82	8.8-10.0	13.0	.029	13.0	.029	78
1,400-lb. cow	.80-.87	9.4-10.6	14.0	.031	14.0	.031	84
1,500-lb. cow	.85-.92	10.0-11.3	15.0	.033	15.0	.033	90
1,600-lb. cow	.90-.98	10.5-11.9	16.0	.035	16.0	.035	96
1,700-lb. cow	.95-1.03	11.1-12.6	17.0	.037	17.0	.037	102
B. For milk production per pound of milk. (To be added to allowances for maintenance.)							
For 3.0% milk ..	.036-.043	.26-.28	1.0	.0022	.75	.0017	.....
For 3.5% milk ..	.038-.046	.28-.30	1.0	.0022	.75	.0017	.....
For 4.0% milk ..	.041-.049	.31-.32	1.0	.0022	.75	.0017	.....
For 4.5% milk ..	.044-.052	.33-.35	1.0	.0022	.75	.0017	.....
For 5.0% milk ..	.046-.056	.35-.37	1.0	.0022	.75	.0017	.....
For 5.5% milk ..	.049-.059	.38-.40	1.0	.0022	.75	.0017	.....
For 6.0% milk ..	.052-.062	.40-.42	1.0	.0022	.75	.0017	.....
For 6.5% milk ..	.054-.065	.42-.45	1.0	.0022	.75	.0017	.....
C. Additional allowances for last 2 to 3 months of pregnancy. (To be added to allowances for maintenance and milk produced.)							
Small cow	.50-.55	5.0-5.5	10.4	.023	6.4	.014	24
1,000-lb. cow	.55-.60	5.5-6.0	13.0	.029	8.0	.018	30
Large cow	.65-.70	6.5-7.0	15.6	.034	9.6	.021	36
D. Additional allowances for milking heifers. (To be added to allowance for maintenance and for milk produced.)							
First lactation ..	.25-.30	1.5-1.8	3.0	.007	3.0	.007	.....
Second lactation	.13-.15	0.8-0.9	1.5	.003	1.5	.003	.....

* Lower amounts, minimum advised. Higher amounts, advised under usual conditions.

TABLE NO. 4. MORRISON FEEDING STANDARDS (22ND EDITION).

Requirements per head daily								
	Dry matter	Digestible protein	Total Digestible nutrients	Calcium		Phosphorus		Caro- tene
	Lbs.	Lbs.	Lbs.	Grams	Lb.	Grams	Lb.	Mg.
2. Growing dairy heifers								
Weight 100 lbs.	1.3- 1.6	.30- .40	1.6- 2.0	7	.015	5	.011	6
Weight 200 lbs.	4.9- 6.1	.53- .62	3.6- 4.4	10	.022	7	.015	12
Weight 300 lbs.	7.0- 8.4	.67- .77	4.8- 5.7	12	.026	8	.018	18
Weight 400 lbs.	9.1-11.4	.76- .87	6.0- 7.0	13	.029	9	.020	24
Weight 500 lbs.	10.9-13.1	.81- .92	6.8- 8.2	14	.031	10	.022	30
Weight 600 lbs.	12.6-15.1	.84- .95	7.4- 9.0	14	.031	10	.022	36
Weight 700 lbs.	14.3-17.2	.87- .98	7.9- 9.7	14	.031	10	.022	42
Weight 800 lbs.	15.9-19.1	.90-1.00	8.5-10.3	14	.031	10	.022	48
Weight 900 lbs.	17.3-20.8	.93-1.03	9.0-10.8	14	.031	10	.022	54
Weight 1,000 lbs.	18.6-22.3	.95-1.05	9.5-11.5	14	.031	10	.022	60

CHARACTERISTICS OF FEEDS

GRAINS, BY-PRODUCTS AND CONCENTRATES

Barley

Barley is higher in digestible nutrients than oats, coming close to corn in this respect. It is essentially an energy or fattening feed. Although ground barley makes a heavy meal it may constitute one-third of the concentrate if it is mixed with oats, bran or bulky protein concentrates.

Beet Pulp, Dried

Dried beet pulp, a by-product of sugar refineries, is often fed as a substitute for silage or roots. It is a bulky feed, laxative, and low in protein. If heavily fed it should be moistened with three times its weight of water before feeding and molasses may be added to take the place of part of the sugar taken out of the beets and to improve the palatability. Soaking is not essential if feeding only a few pounds per day.

Brewers' Grains, Dried

The residue from barley used in the production of malt liquors is known as Dried Brewers' Grains. The carbohydrate content is low and both the protein content and fibre content are quite high. The T.D.N. value will approach that of wheat bran. The high fibre content makes this a bulky feed valuable for use with heavy meals.

Corn

Although the lowest of the grains in protein content, corn is highest in carbohydrates and total digestible nutrients. It is a palatable, readily utilized feed, but should not form more than half the dairy cow's meal ration, being fed in the ground form along with protein concentrates of a bulky nature. Yellow corn is the only grain that supplies appreciable amounts of carotene to the ration.

Corn and Cob Meal

In corn-growing areas the whole ears of corn, including the cobs, may be ground for cattle feed. This mixture contains less protein, considerably more fibre, and 10 to 15% less T.D.N. than corn grain, and is bulkier.

Corn Gluten Feed

This product, sometimes known simply as gluten feed, is a by-product from the manufacture of corn starch, and is quite high in protein, containing about two-thirds the amount in linseed oil meal or cottonseed meal. Since much of the corn bran is contained in this product it has a moderate fibre content, but it is almost as high as corn in total digestible nutrients.

Cottonseed Meal

One of the richest protein sources for dairy cattle is cottonseed meal, the residue from the production of cottonseed oil. It is constipating and is not recommended at freshening time, nor is it too satisfactory for young stock, its use being confined largely to regular production rations.

Hominy Feed

This by-product from the manufacture of hominy flour or grits from corn is similar to corn in over-all feeding value and can be used in the same way as corn.

Linseed Oil Meal

The residue from the production of linseed oil from flaxseed is known as "oil cake" or "oil cake meal" as well as "linseed oil meal". It is high in protein and is used to increase the protein content of meal mixtures. It is highly favoured for test cows and for use at freshening time. The "old process" meal is the more common and contains more fat and T.D.N. than the "solvent process meal".

Oats

The most extensively grown cereal crop in Ontario is oats. The oat grain contains more protein than corn, about the same as wheat or barley and less carbohydrate than corn, barley or wheat. Oats form the basis for most of the concentrate mixtures fed to producing cows in Ontario with the appropriate addition of high-protein supplements and other grains. Ground oats make a desirable bulky meal, and when rolled the bulkiness is greater. The fibrous hulls are low in feeding value.

Soybean Oil Meal

Another high-protein supplement is soybean oil meal, a by-product from the production of soybean oil. Its protein content is generally higher than that of linseed oil meal. The solvent process meal is becoming more common and the fat content and T.D.N. value are below those for the expeller process meal. The protein content is a little higher. This palatable supplement is used in the same way as linseed oil meal or cottonseed meal.

Soybeans

Whole soybeans are frequently used as a protein concentrate, but cannot be used in as great amounts as oil cake because of lower palatability. Soybeans are high in fat and therefore somewhat lower in protein than soybean oil meal.

Wheat

Wheat is rich in carbohydrates and approaches corn in total digestible nutrients. In the ration it can be used in the same way as barley, or may replace part of the oats or the bran. When ground, wheat tends to make a heavy pasty meal. Soft winter wheats can be rolled to overcome this difficulty.

Wheat Bran

Bran is a milling by-product of wheat, and is widely used in dairy rations. It is higher in protein, minerals (especially phosphorus) and fibre than whole wheat, but lower in total digestible nutrients. It is palatable, laxative, and because of its bulk it is useful for mixing with heavier grains.

Wheat Shorts

A somewhat heavier by-product than bran, shorts are higher in T.D.N., lower in fibre, and similar or slightly higher in protein. Their use in cattle rations is limited somewhat by their slightly sticky texture.

ROUGHAGES

Alfalfa

Alfalfa is one of the best roughage feeds, and while it may have limitations as a pasture crop it makes splendid hay. It is richer in protein than red clover hay but contains less fat and carbohydrates. Alfalfa, if cut just when the new shoots are starting at the base of the old plants, yields the maximum amount of feed with a large percentage of leaf. By feeding good alfalfa hay liberally the dairyman

is able to reduce both the amount and the protein strength of the meal ration. It makes an excellent feed for young and growing stock as well as for milk cows. Green alfalfa makes a valuable feed for soiling purposes as it grows rapidly in the spring and comes up quickly after cutting.

Brome Grass

Brome grass is a very common component of mixtures used as combination pasture and hay crops. It is a heavy yielder and has the typical composition characteristics of the grasses.

Red Clover

Red Clover is good legume roughage for all classes of dairy stock when used as a hay, pasture or soiling crop. It does not yield as much per acre as alfalfa but works well into short crop rotations and stands pasturing better. To make the best quality hay it should be cut soon after it is in full bloom and cured to preserve as much leaf as possible. In feeding value it resembles alfalfa.

Sweet Clover

Sweet clover gives best results as a pasture crop, a silage crop and as a soil builder. When used for pasture it should be grazed early in the season to prevent the crop becoming coarse, bitter and unpalatable. It gives best results as pasture when used along with some other crop. It is not held in high favour as a hay crop. Spoiled or mouldy sweet clover should never be fed. Cattle should not be dehorned when being fed on sweet clover.

Corn Fodder

By corn fodder is meant the corn plant with the ear attached. It is a valuable roughage because of the amount that can be grown per acre. It is low in protein but fairly rich in carbohydrates. Cut green in the late summer and early fall it is valuable as a soiling crop. When dried it is used for fall and early winter feeding. Later it becomes dry and woody and should be run through the cutting box to get best results. Corn for this purpose should be thickly sown to get a high percentage of leaf and stem.

Corn Silage

Corn silage is one of the best roughages of silage type for dairy cattle. There is little wastage and, instead of a dry forage, silage supplies a large bulk of succulent feed which is particularly valuable during the winter. Corn for the best quality silage, should be put in the silo when in the dented stage. Silage is also useful for feeding in the summer months when pasture is scarce. In the winter feeding of dairy cattle, silage should be supplemented with a protein-rich feed.

Corn Stover

Corn stover is the corn stalk after the ear has been removed. The crop is more matured than in the case of corn fodder and this detracts from its feeding value. It is of more value than straw and should be run through the cutting box before feeding.

Grass Silage

The name grass silage is given to silage made from any of the common grasses, legumes or mixtures ordinarily used for pasture and hay. The name "hay crop silage" is sometimes used. The composition of the mixture used to fill the

silo will influence the feeding-value of the silage produced, the protein and mineral content increasing with the proportion of alfalfa or other legumes in the mixture. The protein content will generally be better than that of corn silage, but the total digestible nutrients frequently will be lower. Grass silage may be somewhat less palatable than corn silage. The making of grass silage, especially with high proportions of legumes, is more difficult than the making of corn silage. O.A.C. Bulletin No. A102 on "Grass Silage" gives details on making and using grass silage.

Orchard Grass

Orchard grass is grown to a slight extent in Ontario. It is coarser, less palatable and, as a hay crop, is harder to cure than timothy. As a pasture crop it withstands the hot weather well and grows satisfactorily in the shade. It is satisfactory to mix with grasses and clovers in a permanent pasture mixture. Proper management of orchard grass is important to prevent coarse woody herbage.

Roots

Roots are of value as a feed for dairy cattle in that they are palatable, succulent, laxative and easily digested. For all ages of dairy cattle roots form an excellent feed, particularly for young calves just commencing to eat and for test cows where high milk records are desired. Corn silage has very largely replaced the roots, as it furnishes the succulent feed necessary for winter feeding at a lower labor cost.

Straw

All classes of straws are high in fibre and consequently are of little value as a feed for dairy cows. When fed, more concentrates are necessary to properly balance the ration. For dry cows straw may be used as a part of the roughage. Taking everything into consideration, oat straw is the best, barley straw next, with wheat and rye straw lower in feeding value. Buckwheat straw contains a little more protein but is so high in fibre that it is unsatisfactory as a feed. The straw from legumes such as peas and beans has a higher feeding value than that from the cereals.

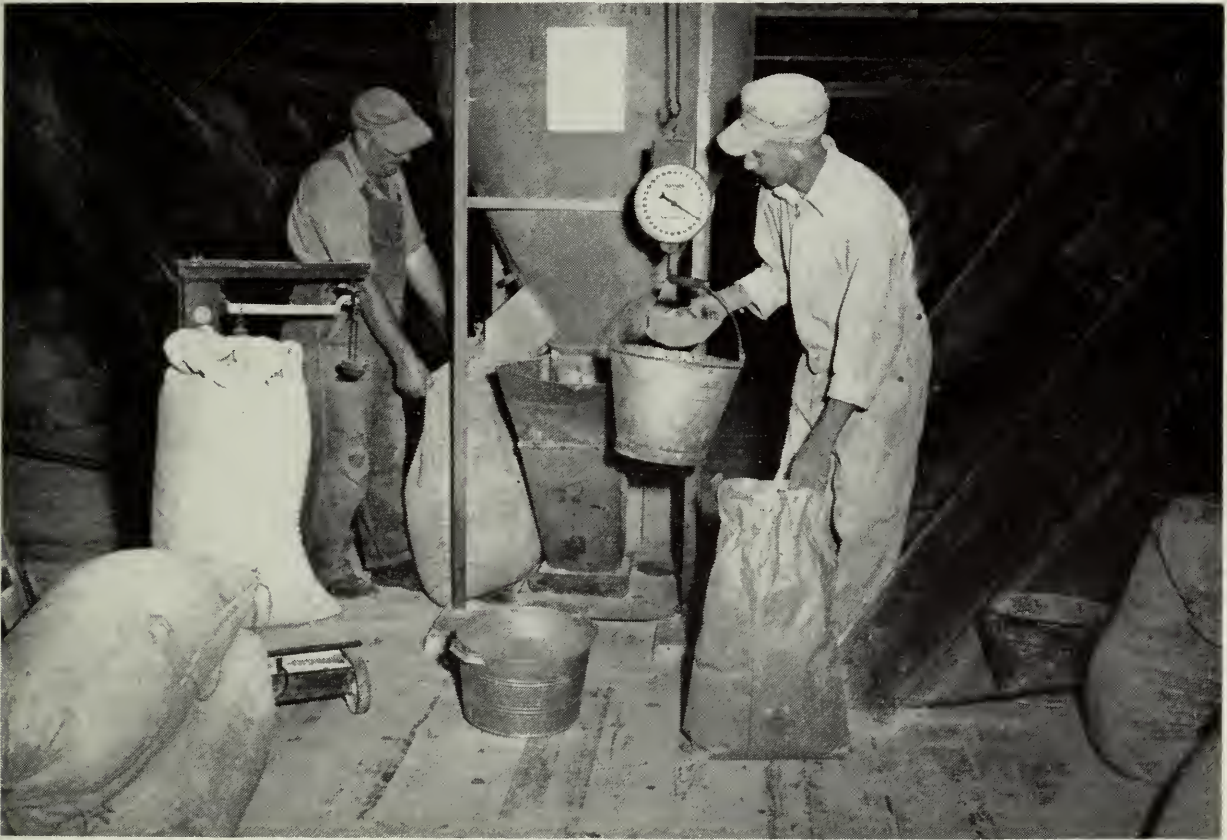
Timothy

While timothy hay is the standard and most satisfactory roughage for horses, it is not so for dairy cattle. It is lower in protein than clover hay and is usually not as palatable. If it is to be used for dairy cattle it is best cut when quite young. Milk cows require more concentrates with timothy than they do with the legume hays.

COMPOSITION OF FEEDS

Different lots of feeding stuffs may vary considerably in chemical composition as the result of variations in many factors including season, soil, processing, and maturity. Nevertheless, under practical circumstances, analysis of all feeds used is out of the question, and use must be made of average figures for feed analyses based on numerous determinations. Such average values are very useful in planning rations to meet recommended allowances.

In Table No. 6 are listed average composition figures for some of the feeding stuffs in common use for dairy cattle. These figures are taken from F. B. Morrison's "Feeds and Feeding" (22nd edition). It should be emphasized that this table gives the average analyses for the products as fed, and not on a dry-matter basis, as is sometimes done.



A knowledge of the composition of feeds is the basis for the successful formulae mixing.

TABLE NO. 5.

COST OF ONE POUND OF TOTAL PROTEIN IN COMMON CONCENTRATE FEEDS

Feed	% of Total Protein	Pounds of Total Protein per Ton	Cost per Pound of Total Protein in Cents, When the Cost per Ton is:									
			\$50	\$55	\$60	\$65	\$70	\$75	\$80	\$85	\$90	\$100
Oats	12.4	248	20.2	22.2	24.2	26.2	28.2	30.2	32.2	34.3	36.4	40.4
Barley	11.5	230	21.7	23.9	26.0	28.2	30.4	32.6	34.8	37.0	39.2	43.4
Wheat	12.4	248	20.2	22.2	24.2	26.2	28.2	30.2	32.2	34.2	36.2	40.4
Corn	10.1	202	24.6	27.1	29.6	32.1	34.6	37.1	39.6	42.0	44.4	49.2
Brewers' Grains (dried)	25.6	512	9.8	10.7	11.7	12.7	13.6	14.6	15.6	16.6	17.6	19.6
Linseed Oil Meal (old process)	33.9	678	7.4	8.1	8.8	9.6	10.4	11.1	11.8	12.5	13.2	14.8
Soybean Oil Meal	44.0	880	5.7	6.2	6.9	7.4	8.0	8.5	9.0	9.6	10.2	11.4
Gluten Feed	25.4	508	9.8	10.8	11.8	12.8	13.8	14.8	15.8	16.7	17.6	19.6
Wheat Bran	16.0	320	15.6	17.2	18.8	20.3	21.8	23.4	25.0	26.5	28.1	31.2
24% Dairy Concentrate	24.0	480	10.4	11.4	12.4	13.5	14.6	15.6	16.6	17.7	18.8	20.8
32% Dairy Concentrate	32.0	640	7.8	8.6	9.4	10.2	11.0	11.7	12.4	13.2	14.0	15.6

TABLE NO. 6. AVERAGE COMPOSITION OF FEEDING STUFFS AS FED

Feeding Stuff	Dry Matter %	T.D.N. %	Digest- ible Protein %	Crude Protein %	Fat %	Fibre %	NFE %	—Calcium—		—Phosphorus—	
								%	grams per lb.	%	grams per lb.
Pastures and Green Roughages											
Alfalfa	24.4	14.8	3.5	4.6	0.9	6.7	10.0	0.40	1.82	0.06	0.27
Alfalfa and Brome Grass (Half Alfalfa)	22.5	13.9	3.3	4.8	0.8	5.3	9.4	0.28	1.27	0.07	0.32
Alfalfa and Timothy (Half Alfalfa)	21.9	14.4	3.5	4.6	0.8	4.7	9.6	0.3	1.36	0.08	0.36
Blue Grass, Kentucky	30.2	20.7	4.1	5.5	1.2	7.6	13.4	0.16	0.73	0.13	0.59
Clover, Ladino	16.6	12.4	3.3	4.1	0.8	2.5	7.5	0.21	0.95	0.07	0.32
Clover, Red, pasture	18.1	13.2	2.8	3.7	0.9	2.9	9.0	0.35	1.59	0.05	0.23
Clover and Mixed Grass, pasture	20.0	13.9	3.4	4.5	0.8	3.6	9.6	0.23	1.04	0.07	0.32
Clover, Sweet, before bloom	20.8	12.8	3.2	4.1	0.7	4.9	9.2	0.34	1.54	0.10	0.45
Corn Fodder, Dent, Tassel Stage	15.0	9.7	1.0	1.6	0.3	4.2	7.8	0.07	0.32	0.05	0.23
Grasses, Mixed, pasture	28.1	19.4	3.7	4.9	1.4	6.1	12.9	—	—	0.09	0.41
Kale	11.8	8.0	1.9	2.4	0.5	1.6	5.5	0.19	0.86	0.06	0.27
Millet	24.7	15.6	1.2	2.0	0.6	7.4	12.9	0.10	0.45	0.06	0.27
Oat Pasture, before heading	14.1	9.2	2.4	3.2	0.6	2.8	5.5	0.06	0.27	0.09	0.41
Oats and Peas	22.7	14.4	2.4	3.2	0.9	6.4	10.3	0.17	0.77	0.07	0.32
Rye Pasture	19.5	12.8	4.0	5.3	0.9	3.4	7.5	0.13	0.59	0.10	0.45
Sudan Grass, pasture	21.6	14.3	2.4	3.3	0.6	5.6	10.2	0.12	0.54	0.10	0.45
Timothy, young pasture	23.9	16.5	3.5	4.7	0.9	4.6	11.1	0.14	0.64	0.09	0.41
Silages											
Alfalfa, wilted, no preservative	36.2	21.5	4.3	6.3	1.4	11.4	13.9	0.51	2.32	0.12	0.54
Clover, Ladino and grass	29.9	21.4	3.9	5.4	1.5	7.5	12.9	0.31	1.41	0.07	0.32
Clover, Red, not wilted	29.5	17.3	2.4	3.7	0.9	9.8	12.6	0.50	2.27	0.07	0.32
Clover, Red, and grass, wilted	35.1	22.2	2.5	4.3	1.1	11.0	15.7	0.39	1.77	0.07	0.32
Corn, Dent, Well-matured	27.6	18.3	1.2	2.3	0.8	6.7	16.2	0.10	0.45	0.07	0.32
Grass Silage, considerable legumes, wilted	33.3	19.1	2.9	5.2	1.3	8.8	14.2	0.25	1.14	0.12	0.54
Timothy, grain added	33.1	19.2	2.3	4.0	1.1	10.4	15.6	0.19	0.86	0.11	0.50
Roots											
Mangels	9.2	7.1	0.9	1.3	0.1	0.8	6.0	0.02	0.09	0.02	0.09
Sugar Beets	16.4	13.7	1.2	1.6	0.1	1.0	12.6	0.04	0.18	0.04	0.18
Hays, Other Dried Roughages											
Alfalfa Hay	90.5	50.7	10.9	15.3	1.9	28.6	36.7	1.47	6.67	0.24	1.09
Alfalfa Meal (Dehydrated)	92.7	54.4	12.4	12.7	2.5	24.0	38.4	1.60	7.26	0.26	1.18
Alfalfa and Brome Grass Hay	89.2	47.9	7.6	11.8	2.0	32.5	36.7	0.77	3.50	0.20	0.91

AVERAGE COMPOSITION OF FEEDING STUFFS AS FED (Continued)

Feeding Stuff	Dry Matter %	T.D.N. %	Digestible Protein %	Crude Protein %	Fat %	Fibre %	NFE %	—Calcium—		—Phosphorus—	
								%	grams per lb.	%	grams per lb.
Hays, Other Dried Roughages (Cont'd)											
Alfalfa and Timothy Hay	89.6	48.2	7.9	12.3	2.1	31.1	37.7	0.83	3.77	0.20	0.91
Clover Hay, Ladino	89.5	59.5	14.2	18.5	1.7	21.6	38.4	1.53	6.95	0.29	1.32
Clover Hay, Red	88.3	51.8	7.2	12.0	2.5	27.1	40.3	1.28	5.81	0.20	0.91
Clover and Timothy Hay (30 to 50% clover)	88.1	51.0	4.7	8.6	2.2	30.3	41.2	0.69	3.13	0.16	0.73
Corn Fodder, well-cured, very dry	91.1	58.8	3.8	7.8	2.2	27.1	47.6	0.27	1.23	0.16	0.73
Corn Stover (ears removed)	90.6	51.9	2.1	5.9	1.6	30.8	46.5	0.54	2.45	0.09	0.41
Millet Hay	90.3	50.7	5.6	9.3	2.2	23.9	47.6	0.29	1.32	0.16	0.73
Mixed Grass Hay	89.0	51.7	3.5	7.0	2.5	30.9	43.1	0.48	2.18	0.21	0.95
Straw, Oat	89.8	44.8	0.7	4.1	2.2	36.3	40.9	0.24	1.09	0.09	0.41
Straw, Wheat	92.6	40.6	0.3	3.9	1.5	37.0	41.9	0.15	0.68	0.07	0.32
Timothy Hay	89.0	49.1	3.0	6.6	2.3	30.3	44.8	0.35	1.59	0.14	0.64
Grains, Seeds, By-Product Concentrates											
Barley	89.4	77.7	10.0	12.7	1.9	5.4	66.6	0.06	0.27	0.40	1.82
Beet Pulp (dried)	91.2	68.7	4.1	8.8	0.6	19.6	58.7	0.69	3.13	0.08	0.36
Brewers' Grains (dried)	92.8	61.9	16.8	23.3	6.2	15.6	43.7	0.29	1.32	0.48	2.18
Corn, Yellow	88.2	82.5	6.9	9.0	3.8	2.4	71.5	0.03	0.14	0.27	1.23
Corn and Cob Meal	86.1	73.2	5.4	7.4	3.2	8.0	66.2	0.04	0.18	0.22	1.00
Corn Gluten Feed	90.3	74.1	21.3	24.8	2.5	7.2	48.1	0.41	1.86	0.80	3.63
Cottonseed Meal	92.9	71.7	33.3	41.6	6.0	10.7	28.1	0.20	0.91	1.11	5.04
Hominy Feed	89.9	83.9	7.5	10.6	6.5	4.7	65.4	0.05	0.23	0.57	2.59
Linseed Oil Meal (old process)	91.1	75.5	30.6	35.2	4.6	8.9	36.7	0.37	1.68	0.86	3.90
Linseed Oil Meal (Solvent process)	91.0	70.3	30.7	36.6	1.0	9.3	38.3	—	—	—	—
Milk, skim, dried	93.9	79.8	29.8	33.1	1.1	0.6	51.1	1.28	5.81	1.04	4.72
Oats	90.2	70.1	9.4	12.0	4.6	11.0	58.6	0.09	0.41	0.33	1.50
Oats, Light weight	91.2	59.8	8.3	12.0	4.5	15.1	54.9	—	—	—	—
Soybean Oil Meal (Expeller or Hydraulic)	91.0	77.9	37.0	44.0	4.9	5.9	30.0	0.27	1.23	0.63	2.86
Soybean Oil Meal (Solvent process)	90.4	78.1	42.0	45.7	1.3	5.9	31.4	0.29	1.32	0.64	2.91
Soybeans	90.0	87.6	33.7	37.9	18.0	5.0	24.5	0.25	1.14	0.59	2.68
Wheat	89.5	80.0	11.1	13.2	1.9	2.6	69.9	0.04	0.18	0.39	1.77
Wheat Bran	90.1	66.9	13.3	16.4	4.5	10.0	53.1	0.13	0.59	1.29	5.86
Wheat Shorts	89.1	77.2	13.8	16.4	3.9	6.0	58.6	0.13	0.59	0.84	3.81

RULES FOR FEEDING DAIRY COWS

Based on the requirements as stated in the feeding standards simple thumb rules have been devised for calculating rations. In applying these rules their limitations must be appreciated. They are not intended to take the place of individual attention as they may provide too much feed for cows that are nearly dry and indicate inadequate amounts for heavy yielders and immature milkers. Despite shortcomings these feeding rules have a place in formulating the basic rations for the herd.

ROUGHAGE FEEDING:—

- 1½ lbs. hay and 3 lbs. silage per 100 lbs. live weight
or
1½ lbs. hay, 2 lbs. roots and 2 lbs. silage per 100 lbs. live weight
or
1½ lbs. hay and 4 lbs. roots per 100 lbs. live weight
or
2 to 2½ lbs. hay per 100 lbs. live weight.

GRAIN FEEDING:—

1. Feed daily 1 pound of meal mixture for every 3 to 5 pounds of milk produced.
2. When feeding alfalfa or clover hay, with or without silage or roots, use a meal mixture containing 15 to 17 per cent total protein.
3. When feeding timothy or grass hay, with or without silage or roots, use a meal mixture containing 17 to 19 per cent total protein.

SUGGESTED MEAL MIXTURES FOR DAIRY COWS IN MILK:—

- (a) Examples of meal mixtures containing 15 to 17 per cent total protein suitable for feeding with good alfalfa or red clover hay, with or without silage.

1. Oats	500 lbs.
Barley	200 lbs.
Corn Gluten Feed	100 lbs.
Wheat Bran	100 lbs.
Linseed Oil Meal	100 lbs.
2. Oats	450 lbs.
Corn and Cob Meal	200 lbs.
Wheat Bran	100 lbs.
Dried Brewers' Grains	100 lbs.
Soybeans	150 lbs.
3. Oats	500 lbs.
Barley	200 lbs.
Wheat	150 lbs.
Linseed Oil Meal	150 lbs.
4. Oats	500 lbs.
Barley	200 lbs.
Wheat Bran	200 lbs.
Soybean Oil Meal	100 lbs.
5. Mixed Grain	700 lbs.
Commercial Dairy Concentrate (24%)	300 lbs.
6. Mixed Grain	800 lbs.
Commercial Dairy Concentrate (32%)	200 lbs.

SUGGESTED MEAL:—

Examples of meal mixtures containing from 17% to 19%. To be fed with mixed hay (chiefly grasses) or timothy hay, with or without silage or roots.

1. Oats	400 lbs.
Barley	100 lbs.
Wheat Bran	200 lbs.
Linseed Oil Meal	100 lbs.
Cottonseed Meal	100 lbs.
2. Oats	300 lbs.
Wheat	100 lbs.
Corn	100 lbs.
Wheat Bran	200 lbs.
Cottonseed Meal	100 lbs.
Linseed Oil Meal	100 lbs.
3. Oats	400 lbs.
Barley	100 lbs.
Wheat	100 lbs.
Soybeans	200 lbs.
Linseed Oil Meal	100 lbs.
4. Oats	400 lbs.
Barley	100 lbs.
Wheat	150 lbs.
Linseed Oil Meal	250 lbs.
5. Mixed Grain	500 lbs.
Commercial Dairy Concentrate (24%)	500 lbs.
6. Mixed Grain	800 lbs.
Commercial Dairy Concentrate (32%)	300 lbs.

Considerable variation exists in the kinds and amounts of grains and protein supplements available for the making of grain mixtures. To facilitate the formation of these from a wide variety of ingredients "pattern" formulae as outlined are useful:

15-17% TOTAL PROTEIN:—

- (a) To be fed with good alfalfa hay or red clover hay, with or without silage or roots.
- (1) 300 lbs. Ground or rolled oats
 - (2) 200 lbs. Ground or rolled barley OR ground corn OR rolled wheat OR hominy feed OR any combination of these feeds.
 - (3) 200 lbs. Bran OR equal parts of bran and shorts OR equal parts of bran and dried brewers' grains OR equal parts of bran and corn gluten feed.
 - (4) 100 lbs. Linseed oil meal OR soybean meal OR cottonseed meal
OR ground soybeans OR any combination of these feeds.
-
- 800 lbs. Total Mixture.

17-19% TOTAL PROTEIN:—

- (b) To be fed with mixed hay (chiefly grasses) or timothy hay, with or without silage or roots.

- (1) 300 lbs. Ground or rolled oats.
 - (2) 200 lbs. Ground or rolled barley OR ground corn OR rolled wheat OR hominy feed OR any combination of these feeds.
 - (3) 200 lbs. Bran OR equal parts of bran and shorts OR equal parts of bran and dried brewers' grains OR equal parts of bran and corn gluten feed.
 - (4) 200 lbs. Linseed oil meal OR cottonseed meal OR soybean oil meal OR ground soybeans OR any combination of these feeds.
-
- 900 lbs. Total Mixture

Mix 1 to 2 lbs. of salt with each 100 lbs. of meal mixture.

Mix 2 lbs. of feeding bone meal with each 100 lbs. of mixture.

OR

Provide commercial mineral mixture in amounts recommended by manufacturers.

FEEDS AND FEEDING POINTERS:—

1. A basic standard for the meal mixture for milking cows is:
 Total protein 15-19% (depending on roughage)
 Total digestible nutrients 72-77%
 Total fibre not more than 10-12%
 Total fat 3% or more.
2. Avoid fine grinding — coarse grind or roll grains.
3. Feed according to the needs of each animal.
4. Feed definite amounts at regular hours.
5. Avoid sudden changes in the amount and the kinds of feed.
6. Keep mangers clean and sweet.
7. Provide adequate amounts of not too cold water.

SUGGESTED FORMULA FOR 24% DAIRY CONCENTRATE:—

1. Bran	200 lbs.
Gluten Feed	200 lbs.
Dried Brewers' Grains	200 lbs.
Linseed Oil Meal	200 lbs.
Soybean Oil Meal	150 lbs.
Iodized cobaltized salt	20 lbs.
Bonemeal or cattle mineral	30 lbs.

SUGGESTED FORMULA FOR 32% DAIRY CONCENTRATE:—

1. Bran	100 lbs.
Gluten Feed	100 lbs.
Linseed Oil Meal	400 lbs.
Soybean Oil Meal	300 lbs.
Iodized cobaltized salt	30 lbs.
Bonmeal or cattle mineral	70 lbs.



Feeding time — Regularity of feeding and the correct amount add up to a healthy appetite.

STABLE FEEDING

Best results in rationing cows during the stable feeding period are obtained when emphasis is placed on the feeding of liberal amounts of good quality roughages rather than on the feeding of large amounts of grain concentrates. However, cows capable of producing large amounts of milk will not reach or maintain a high level of production if fed roughage feeds only. They cannot eat enough of the bulky feeds to supply all the nutrients required and the grains and by-products must be used to provide a portion of the nutrients in a more concentrated form.

The best hay for cows is green coloured, leafy, fine-stemmed legume or mixed grass and legume hay free from mould, mustiness and weeds. In general cows should receive all the hay they will eat without undue waste. More good quality hay will be consumed than poor quality stemmy coarse hay and the intake is greater when fed three times a day than when fed twice a day. If the hay supply varies in quality, feed some good hay and some inferior each day rather than all the good hay for a time and then all the poor hay. Also under these conditions an attempt should be made to give the high yielders rather larger amounts of good hay than the nearly dry cows. Silage, corn or grass, of good quality makes an excellent roughage type feed for cows and growing heifers. The amount consumed will depend on the quality of the silage and on the volume of hay fed.

Root crops, such as mangles, make an excellent feed for milking cows. However, the high cost of production makes this type of feed too expensive for general use. When available the root crops are usually confined to feeding during the freshening period or to the very high yielders.



Knee deep in luscious pasture fills the milk pail.

The amount and kind of grain mixture needed is dependent on the amount and quality of roughage fed. In general, the more nearly the roughage is all-legume the lower the amount of protein needed in the grain mixture.

SUMMER FEEDING

Fresh green pasture is the most nearly ideal feed for dairy cows. Excellent pasture is capable of supporting higher milk production than ordinary barn feeding and is the most important single factor in economical milk production. Unfortunately the period of time that excellent pasture is available is often quite short and to provide sufficient nutrients for high milk production supplemental feeding is necessary.

Spring pastures are high in water content, rich in protein, low in fibre and palatable. As pastures mature the protein content lowers, the fibre increases, and palatability and digestibility decrease. A proper appreciation of the wide variation in the feeding value of pasture throughout the season is fundamental. The lack of uniformity can be overcome only by proper management, the use of emergency pasture crops, green feeds, silage, and grain feeding.

The more important considerations in pasture management are the avoiding of too early grazing and overgrazing, seeding, fertilizing, and the controlling of weeds and excess growth. Overgrazing reduces the yield, increases injury from drought and encourages the growth of weeds. Undergrazing is not as common or as serious a fault as overgrazing; however, it is wasteful and stimulates the growth of coarse woody herbage. Harrowing pasture land late in the fall will tend to spread the manure droppings and prevent excessive bunching of the pasture.



Annual pasture is useful in supplementing regular pasture.

The amount of grass consumed daily varies and intake is dependent chiefly on the palatability and the abundance of the pasture. Medium to large sized cows will eat from 125 to 150 pounds of grass per day which should provide nutrients sufficient to maintain the cow and a level of milk production at about 30 to 35 pounds per day. These are nearly maximum figures and would apply only under nearly ideal conditions.

Since many cows produce more than 35 pounds per day on pasture extra feed is necessary if herd production and body weight are to be maintained. Grain feeding cows when on pasture requires careful thought and management on the part of the feeder to prevent wastage of feed on one hand or a drop in milk yield and in body weight on the other. Feeding schedules are given, but before applying, due consideration should be given to the pasture conditions, the time of the year, and the level of milk production.

AMOUNT OF CONCENTRATES TO FEED ON PASTURES

Milk Produced Daily on Good Pasture (lbs.)	Pounds of Concentrates Required Daily According to Milk and Test of Milk				
	3.0%	3.5%	4.0%	4.5%	5.0%
15					1.2
20	1.5	2.0	2.4	3.8	4.2
25	3.0	3.6	4.2	5.6	6.2
30	4.5	5.2	5.9	7.5	8.2
35	6.7	7.6	8.5	10.3	11.2
40	8.2	9.2	10.2	12.1	13.2

Since young grass is high in protein the grain fed while the cows are on this need not have a high protein content but should supply readily available nutrients to meet the energy requirement. Home grown grains may suffice. As the pasture herbage matures the protein content of the grain mixture should be increased. In selecting a grain mixture due consideration must be given to the condition of the pasture, the production of the cattle, the price of the feed, and the market price of the product.

GRAIN MIXTURES FOR COWS ON GOOD PASTURE

1. Oats	200 lbs.
Barley	100 lbs.
2. Oats	200 lbs.
Barley	100 lbs.
Wheat	100 lbs.
3. Oats	100 lbs.
Barley	100 lbs.
Wheat	100 lbs.
Soybean Oil Meal	50 lbs.
4. Oats	200 lbs.
Wheat	100 lbs.
Rye	100 lbs.
Linseed Oil Meal	100 lbs.

GRAIN MIXTURES FOR COWS ON POOR TO MEDIUM PASTURES

1. Oats	200 lbs.
Barley	100 lbs.
Wheat	100 lbs.
Soybean Oil Meal	100 lbs.
2. Oats	200 lbs.
Wheat	200 lbs.
Dried Brewers' Grains	100 lbs.
Linseed Oil Meal	50 lbs.
3. Oats	300 lbs.
Barley	100 lbs.
Soybean Oil Meal	100 lbs.
4. Oats	200 lbs.
Barley	100 lbs.
Corn Gluten Feed	100 lbs.
Linseed Oil Meal	50 lbs.

Improved pasture provides a large yield of nutrients per acre and is the corner stone of the summer feeding programme. Adverse weather conditions, winter killing and other factors may reduce the pasture yield, and roughage from other sources is needed. Silage made from corn or grass is very satisfactory for this purpose. To have corn silage available it must be saved from the material stored in the previous season. If this is not available, the excess growth of early pasture or some of the hay crop could be ensiled early in the season and fed out during the mid-summer season as grass silage. Material of this type is used to make up for the inadequacy of pasture volume not as a substitute for grain feeding.

Occasionally emergency crops are used to make up for lack of pasture volume. Green oat pasture, sudan grass, millet and other growing crops or



For the milking herd the aftermath of hay fields is a good source of pasture.

combinations can be used for this purpose. These emergency or temporary pastures do not yield as much as those regularly used, often do not stand treading well and always necessitate labour and expense in seeding. They are important as supplements to the regular pastures and in lengthening the grazing season.

Sudan grass, a member of the sorghum family, makes an excellent mid-summer pasture, particularly during a hot, dry season. It is a high yielder, is very palatable and a good milk producer and should be seeded late in May or early in June at the rate of 25 to 30 pounds of seed per acre. Unfortunately, this crop has some liabilities. The seed is often expensive and may have poor germination. During a cold and a wet season the yield is frequently low and like all members of the sorghum family there is some danger from prussic acid poisoning. Sudan grass is not a serious offender, but as a precautionary measure do not pasture when the plants are small or when badly stunted or frozen. Turn the cows on the pasture when it is 18 to 20 inches high. In districts where corn can be successfully grown, sudan grass has possibilities as a temporary pasture crop, particularly during hot, dry seasons.

Fall rye seeded at the rate of about two bushels per acre between August 1st and 15th is useful as late-fall and early-spring pasture. In pasturing rye care must be exercised to prevent a feed flavour occurring in the milk. Allow the cows on rye pasture for a few hours each day, and have them off the rye for about two hours before milking time to overcome flavour difficulties. Some dairymen mix oats with the rye to thicken the pasture for fall grazing.

Green Feeds or Soiling Crops

Soiling crops are cut in the green stage, hauled to the barn or pasture field, and fed as green feed. They are of considerable value in keeping up milk

flow, particularly when pasture is scarce. Unfortunately a large amount of labour is required in growing and harvesting, but this method of supplying feed is very efficient in the utilization of the green material. There is little wastage, good response is observed in maintained or increased milk yield, and large amounts of feed can be grown on a small acreage. Alfalfa for cutting early in the season and corn for use later makes good soiling crops.

Miscellaneous Pasture Pointers

Cows are creatures of habit and respond to regularity and routine in management practice. In addition to supplying a uniform amount of roughage throughout the summer season and supplementing this where necessary with grain some attention must be given to factors other than feeding if high milk yield is to be maintained.

Cows require large amounts of fresh water, milk contains about eighty-five per cent. If possible have a continuous supply of fresh water in the pasture field and definitely avoid stagnant water from mud holes and swamps. While not absolutely necessary, shade undoubtedly adds much to the comfort of the cattle. A few trees in the field or along the fence line will give protection against the sun during the heat of the day.

Regular pastures must of necessity be a part of the farm crop rotation. Wherever possible, however, pasture land should be located near the barn. Walking cows long distances to and from the pasture field is not conducive to high milk yields for, in addition to using much energy, it predisposes the cows to udder injury and sore and cracked feet.

FEEDING THE COW DURING THE DRY PERIOD

Dairy cows should be given a rest by drying them about 6 to 9 weeks before refreshing. A longer rest period may be necessary to properly fit very thin cows or the young cows that may need extra size. Records of service dates are necessary to insure a dry period of adequate length yet not so long that many of the cows are non-productive for many months. The milk market and the market for surplus breeding stock are factors to consider in planning the dates of breeding, rest periods and freshening dates.

Drying the cow may be difficult particularly if she has been milked to within two or three weeks of freshening. If this has happened it is wise to continue milking, feed liberally and expect production in the next lactation period to be low. Cows, some weeks from freshening, may be dried by reducing the feed and water intake, milking occasionally and if possible removing them from the regular milking line.

Another method of drying is to discontinue milking abruptly. Change the milking routine, remove the protein rich feeds and reduce the grain and the water intake. Allow the udder pressure to build up and in this way prevent the secretion of milk. If the udder should become unduly congested milk out thoroughly and start over. This method is not advised for cows with a history of mastitis trouble.

After drying, the cow should be liberally fed to increase body weight, build up a reserve of minerals and develop a strong vigorous foetus. This requires the use of good roughages and of grain mixtures that are more than just fattening feeds. The regular production grain ration is satisfactory or a special dry and fitting mixture could be used.

FORMULA FOR DRY AND FITTING GRAIN MIXTURE

Rolled Oats	400 lbs.
Rolled Wheat	100 lbs.
Corn and Cob Meal	50 lbs.
Wheat Bran	100 lbs.
Beet Pulp	50 lbs.
Linseed Oil Meal	170 lbs.
Molasses	100 lbs.
Bonemeal	20 lbs.
Cobalt — Iodized Salt	10 lbs.

The amount of grain fed will depend on the condition and size of the cow. It may range from only a few pounds to eight or ten pounds per day. Cows in good condition on pasture are not likely to require additional feeding in the form of grain.

As calving time approaches it may be necessary to reduce both the amount and kind of grain fed because heavy feeding up to freshening may result in excessive swelling and congestion of the udder in some cows. If signs of this type of trouble are in evidence reduce the volume of grain mixture fed and switch to a simple laxative type of feed. The following combination is suggested for feeding just prior to and also after freshening until the udder swelling and congestion have been reduced:

Oats (rolled)	250 lbs.
Wheat Bran	100 lbs.
Oilcake	50 lbs.

Premilking (milking the cow before calving) will, in at least some cases, prevent undue swelling and congestion. Certain factors should be appreciated before starting a management change of this type otherwise more harm than good may result.

1. Commence premilking before the udder becomes extremely hard and congested. This may vary from a few days to a month before freshening.
2. Once started continue milking — only a small amount of fluid will be obtained in the first milkings but the amount of secretion should increase after a few days. Do not start the secretion process and then because of the small amount of milk, extra work, or for some other reason discontinue milking.
3. Premilking, when properly done, will not injure the cow. Trouble in raising the newborn calf may result from the changed character or the absence of colostrum.

Cows vary in symptoms indicating calving but the individuals are fairly constant in the symptoms at each lactation. Some “make-up” quickly, others slowly. The signs indicating the approach of calving are:

1. Swelling of the udder with the teats filling and showing a waxy appearance a few hours before freshening.
2. The vulva is swollen and a relaxing of the muscles around the tail head is characteristic.
3. Restlessness and if on pasture a tendency to segregate from the main part of the herd.

During the stable feeding period the cow should freshen in a clean disinfected, well bedded box stall. Even during the pasture season it is wise to freshen the cow in a box stall or a paddock near the barn where she can be observed frequently. After freshening the cow should be allowed to lick the calf, kept warm and be fed sparingly. A drink of warm water and a warm bran mash, improved by the addition of molasses, is a recommended practice in getting the cow over the strain of calving. Observe the cow at intervals to detect the early symptoms of milk fever or acetonemia. (See section on diseases). If the afterbirth membranes are not expelled after approximately two days procure the services of a veterinarian.



Off to a good start — A clean stall, and a healthy cow.

FEEDING AND CARE OF THE CALF

Shortly after birth the calf should nurse. The colostrum or first milk has properties that apparently activate the digestive tract of the newborn calf and also builds up the resistance to disease. Disinfecting the naval stump with a weak solution of tincture of iodine will serve to guard against infection entering at this point.

The calf could be left with the dam for a few days or may be removed within twenty-four hours of the time of birth. When a cow has a bad case of udder congestion leaving the calf with the cow for a time may tend to relieve the condition. However, under all circumstances the udder should be watched to detect undue swelling in individual quarters, sore teats or injuries. Leaving the calf with the cow for several days may predispose it to a scouring condition from overfeeding and also makes it more difficult to train the calf to drink from a pail.

Points to Consider in Rearing Young Calves

1. *Regularity of feeding.* The young calf will often respond to more frequent feeding than the usual morning and evening feeding practices which are sufficient when the calf has reached the age of one week to ten days.
2. Uniformity in quality, temperature (in case of milk), and quantity of feed.
3. Cleanliness of *all* feeding utensils.



An individual pen ensures comfort and health.

4. Keep calves dry, clean, free of external parasite and in a well lighted properly ventilated pen.
5. Avoid under-feeding or over-feeding.
6. Allow opportunity for calves to take exercise.

Various methods of feeding calves are used after they have reached approximately three weeks of age. Regardless of the feeding procedure used whole milk should be fed for at least a three week period following the first few days on colostrum. During the third week on whole milk a gradual change could be made in the feeding schedule to reduce the cost of feed and possibly the amount of labour. The methods in common use are:

- A. Skimmilk feeding,
- B. Limited whole milk supplemented with calf starter,
- C. The use of milk powders, or milk replacers, and
- D. Raising calves on nurse cows.

A. SKIMMILK FEEDING

Where skimmilk is available it may be gradually substituted for the whole milk commencing the change when the calf is about 3 weeks old. At about four weeks of age the calf should be fed daily about 10% of its body weight in skimmilk. This amount could be gradually increased to about sixteen pounds daily and fed at this rate until the calf is 4-5 months of age. If available, feeding

for a longer period is advised but regardless of age the transition from skimmilk feeding to dry feed rationing should be made gradually. Calves being reared on skimmilk should receive in addition to the milk liberal amounts of good quality hay, some grain, salt, mineral and regulated supplies of water.

TABLE NO. 7. FEEDING SCHEDULE FOR SKIMMILK FED CALVES

Age of Calf	Whole Milk	Skimmilk	Grain Mixture *	Hay	Mineral
	(Lbs. Daily)	(Lbs. Daily)			
1-3 days	With dam or milk from dam				
3-14 days	8 - 10	None	None	None	None
3rd week	11 - 5	0 - 6	Small amount in pail	All will eat	Cattle
4th week	5 - 0	6 - 12	About ¼ lb.		mineral mixture.
5th and 6th week		12 - 14	Increase slowly to ¾ lb.		All will
7th to 20th week or older		14 - 16	¾ to 3 lbs.		eat.

* Oats 250
 Bran 100
 Oilcake 50

B. LIMITED WHOLE MILK FEEDING

When this method of feeding is practiced the total amount of milk allowed for each calf is approximately 350 pounds. Calves of the larger breeds will receive greater quantities per day but for fewer days than calves of the smaller breeds. The milk should always be fresh and fed at about the same temperature — preferably from 95° to 98° F.

- The following schedule is recommended:
- First Week* — Every calf should be allowed to remain with its dam for from one to four days, during which period it should be taught to drink from a pail. After weaning the amount of milk consumed at each feed will depend upon its size and appetite. Generally speaking its daily allowance during the first week of its life should not exceed eight pounds or eight per cent of its body weight, whichever is the lesser amount.
- Second Week* — The quantity of whole milk may be increased gradually until it reaches 10 pounds per day or 10 per cent of its body weight, whichever is the lesser amount.
- Third Week* — Whole milk should not exceed ten pounds per day.
- Fourth Week* — Whole milk should not exceed nine pounds per day.
- Fifth Week* — Whole milk should not exceed seven pounds per day.

Sixth Week — Whole milk should not exceed six pounds per day.

Eighth Week — Whole milk should not exceed four pounds per day.

During the third week calves should be fed dry calf-starter, twice daily, in such quantities as they will eat. Actually they seldom eat much at first, but their appetities rapidly improve with age. Thus the quantity of starter should be increased with each succeeding week until the average daily consumption of the offspring of the larger breeds is four pounds.

Commercial starters are available in either dry-meal or pellet form. Either type may be fed in a box or trough, but any that is left over should be removed before the next feeding. Calves usually start to drink water at about three weeks of age, consequently when that age is reached clean, fresh water should be made available to them daily. Sometimes they acquire the habit of drinking too much, so during the early stages the supply should be controlled lest this occur.

When calves reach the age of 7-8 weeks a portion of the starter should be replaced by concentrates and the process continued gradually until the starter is entirely replaced. Usually calves prefer concentrates that are coarse and fairly bulky to those which are finely ground. This preference should be kept in mind when the change-over is being made. Actually a good heifer ration or even a ration consisting of rolled oats or whole oats is quite suitable. In addition salt and minerals should be fed if they are not incorporated in the mixture. Because of its beneficial effect upon body development good quality grass-legume hay constitutes a vital part of the ration. When "straight" legume hay is fed scours frequently develop.

Calf starters manufactured by reliable firms cost about the same as home mixed starters. Furthermore, they are usually more uniform in quality and contain the necessary ingredients that may be hard to procure on the retail market and difficult to mix. However, if home mixing is desired, the following formula will serve as a guide:

Formula for a Calf Starter

300 lbs. of crushed oats	
200 lbs. of rolled oat groats	
100 lbs. of crushed barley	
200 lbs. of coarsely ground corn	
100 lbs. of rolled or coarsely ground wheat	
100 lbs. of bran	
75 lbs. of middlings	
200 lbs. of soybean oilmeal	
300 lbs. of oilcake meal	
100 lbs. of dehydrated alfalfa meal	
100 lbs. of molasses	
50 lbs. of fish meal	
100 lbs. of skimmilk powder	
20 lbs. of iodized salt	
35 lbs. of bone meal or defluorinated phosphate	
20 lbs. of brewers' yeast	
2000 lbs.	

To each ton add:

Cobalt sulphate	3 gms.
Riboflavin	2,000,000 units
Vitamin D	1,000,000 units
Vitamin A	4,000,000 units
Aureomycin Feed Supplement	20 gms.

TABLE NO. 8. SUGGESTED SCHEDULE FOR DRY CALF MEAL FEEDING

Age of Calf	Whole Milk (Lbs. Daily)	Calf Meal	Grain Mixture *	Water	Hay
1-3 days	With dam or milk from dam				
3-14 days	8 - 10				
3rd week	10	Small amount in pail. Small amount (dry) in feed box.		Warm water. 1-2 lbs. with milk.	All calf
4th week	9 - 7	Keep dry feed before calf. Keep box clean and meal fresh.		Gradual increase to compensate for reduced milk intake	will clean up.
5th week	7 - 6	Same as 4th week		Same as 4th week	Feed
6th week	6 - 5	1½ to 2 lbs. per day	About 1½ per day	Should be getting about 15 lbs. daily	fresh
7th and 8th week	4 - 0	2 to 3 lbs. per day	About 2 lbs.	All water calf will drink	daily.
8th week on to 20th	—	3 lbs. or probably more for large calves	Increase until getting about 2-3 lbs.	All water calf will drink	

This schedule should not replace the manufacturer's schedule. Calf meal will contain necessary minerals.

* Grain mixture could be oats 250; bran 100; oilcake 50; or any good 16% dairy ration or oats alone. For good results in dry calf feeding liberal amounts of good quality hay are essential. Watch the temperature and the amount of water consumed when changing from milk to dry feeding.

C. MILK POWDERS OR MILK REPLACERS

Reconstituted powdered skim milk, made by mixing one pound of powder with 8-9 pounds of water, makes an excellent but often quite expensive feed for calf rearing. The reconstituted product can be used in the same manner and fed at the same rate as fresh skim milk. Dried buttermilk may be used in the same way as dried skim milk but it often lacks palatability so difficulty is encountered in getting some of the calves to drink it. Very satisfactory new products for calf feeding made from milk constituents are being offered on the market. The use of these in feeding, like all milk powders, is governed by price and procurability.

In recent years some calves have been raised on commercial milk replacers. Under this method of feeding, calves should receive the dam's milk for the first three days, switching on the fourth day to a combination of whole milk, water and milk replacer. Generally by the tenth day whole milk is no longer fed and a similar feeding schedule as outlined under the "Limited Whole Milk Feeding" should then be followed with the milk replacer and water replacing the whole milk.

D. NURSE COWS FOR CALVES

Nurse cows particularly on large farms where some older brood cows may be available, are used quite successfully to rear calves. Several calves may be reared on one cow throughout a lactation period. The calves should not be left with the cow continually and her udder should be closely watched to detect injuries and irregularities in the nursing of the quarters. Calves reared on nurse cows should have free choice of hay, be fed some grain and have access to salt, minerals and water.

Regardless of the method used in rearing certain management factors must be given careful consideration if disappointments are to be avoided. Good quality in the feeds, regularity in feeding routine, cleanliness of feeding utensils and calf pens, freedom from draughts and excessive humidity in the winter stabling-quarters and protection from heat and flies while on pasture are but a few of the factors that play an important role in successful calf rearing.

Efforts should be made to reduce sucking. An individual calf pen is the best solution but if this is not possible leave the calves tied for a time after pail feeding and give some dry feed in the pail. This habit may seriously distort the udder in its formative stage and has been known to persist even after the calves have developed and come into production.

Horn growth can be stopped when the calves are young by applying one of the caustic preparations or using electric dehorers on the developing horn buttons. Identification, by tagging, tattooing or drawing, should be recorded at an early age to avoid errors. Extra teats are easily removed on calves and excessive foot growth should be trimmed off. A bad infestation of lice may be the cause of unthriftiness and a calf with a dry shaggy coat should be examined for external parasites. If the herd is operating under a vaccination program have the calves vaccinated when from six months up to eight months of age. Haltering and tying occasionally will greatly reduce the labour involved in halter breaking.

The period of changing from calf feeding may cause a serious setback unless certain precautions are taken. As the calf reaches this stage, about 5-6 months old, make certain it is feeding on liberal amounts of dry feed and reduce gradually the milk or milk substitute. Aim to keep the calf growing, avoiding extreme thinness on one hand and excessive fatness on the other. All the good hay and silage the heifer will consume may be sufficient to keep it in proper condition but two to four pounds per day of a simple grain mixture may be needed to supplement the roughage feed. Minerals and salt should be made available.

Age to Breed

Heifers well grown for age can be bred earlier than those that are under-developed. Freshening at the most desirable season of year from the standpoint of marketing the milk may be a governing factor. The smaller breeds usually mature at a somewhat younger age than larger breeds. Table No. 9 will serve as a guide to the proper age to breed well developed heifers for first gestation period.

TABLE NO. 9. AGE TO BREED

Breed	In Months
Holstein	18 to 21
Ayrshire	17 to 20
Guernsey	16 to 19
Jersey	15 to 18

Normal Growth

It is helpful to have a normal standard in order to determine whether young cattle are making the proper rate of growth. Weight at a certain age, weight for height at withers and weight for heart girth measurement are different types of standards used to measure the rate of growth and development. Morrison in Feeds and Feeding presents a very complete summary of the experimental work on growth. The average weight at one year of age for Ayrshires was reported as 518 pounds; Guernseys 490 pounds; Holsteins 653 pounds; and for Jerseys 462 pounds; growth is less rapid during the second year than the first. In all breeds males are heavier and make more rapid gains than females.

TABLE NO. 10. NORMAL GROWTH IN WEIGHT AND HEIGHT OF DAIRY CATTLE

Age	Ayrshire Heifers		Guernsey Heifers		Holstein Heifers		Jersey Heifers	
	Weight lbs.	Height ins.	Weight lbs.	Height ins.	Weight lbs.	Height ins.	Weight lbs.	Height ins.
1 mo.	86	27.0	79	28.4	113	30.5	68	26.9
2 mo.	114	28.4	105	30.0	150	32.2	92	28.8
4 mo.	190	32.0	177	33.7	250	36.2	164	32.7
6 mo.	281	35.3	267	37.2	365	39.8	250	36.2
8 mo.	371	37.7	350	39.9	474	42.4	331	39.1

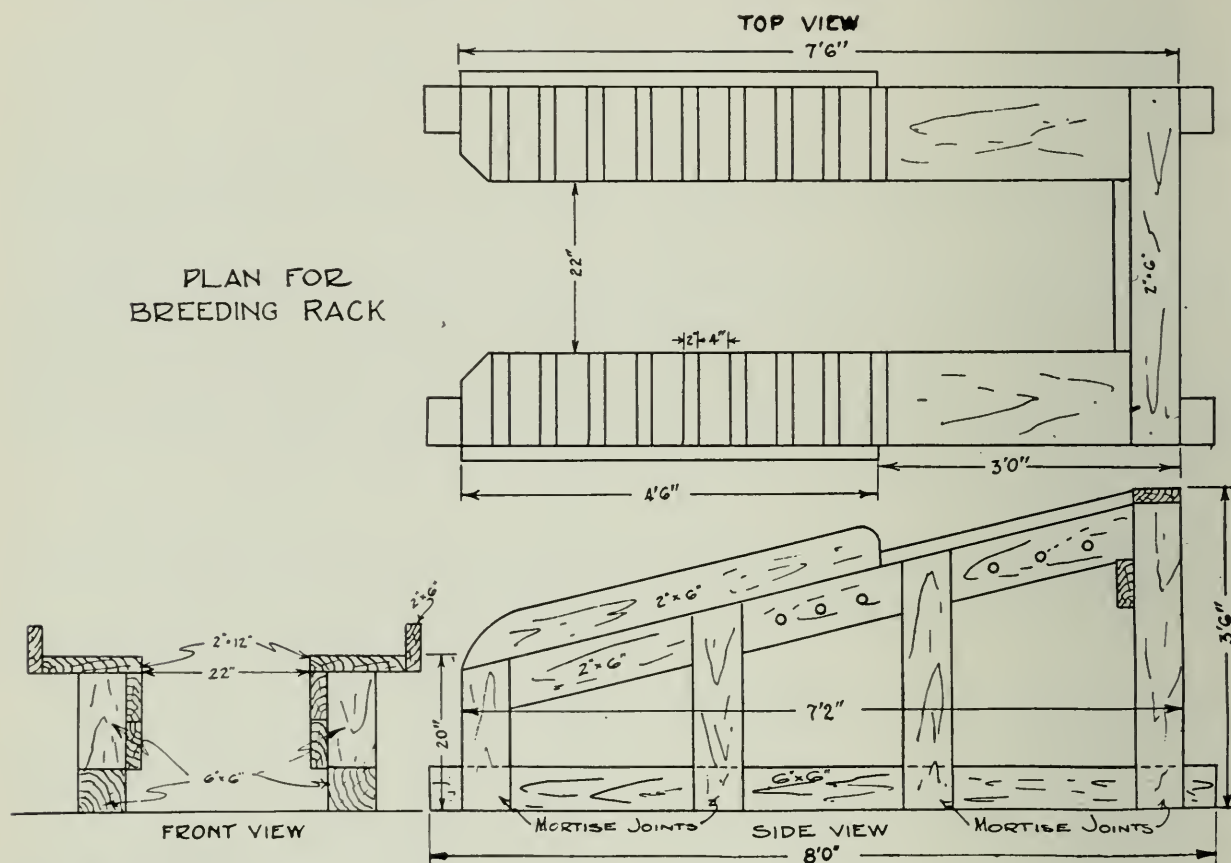
Veal Production

Each year many dairy calves are marketed as veal. Nothing but whole milk will produce veal of high quality and it requires about ten pounds of milk to produce one pound of gain. A veal calf nursing seems to do better than one that is pail fed on whole milk. The original weight of the calf, the value of milk, the price of veal and the availability and efficiency of labour are some of the factors that must be considered in evaluating the efficiency of veal production.

FEEDING AND MANAGEMENT OF THE BULL

The Young Bull

The feeding and management of the young bull calves is essentially the same as that followed in rearing the heifer calves. However, as bull calves are usually raised for sale the feeding of milk substitute is often continued for a longer period of time than with the heifers. They should be separated from the heifer calves when about six months of age and as far as feasible kept in individual pens. Feed liberally on hay and grain and in the winter, provide limited amounts of silage and in the summer some green feed. Allowing the young animals outside for some time each day will insure exercise resulting in stronger legs and better shaped feet. When about one year of age a ring should be put in the nose and some stern handling practised during this period may serve to make the bull more manageable throughout his lifetime. Well grown bulls may be put at light service when about twelve months old but heavy service at this age may impair the future usefulness by making him a slow, indifferent or impotent breeder.



The Breeding Bull

Breeding bulls that are in heavy service in large herds or in artificial insemination units may require special rations. However, bulls in the average sized dairy herd can be kept in good breeding condition on the same type and mixture of feeds as used in rationing the cows. The amount of succulent feed such as silage may have to be reduced below the amount fed the cows. The amount of grain fed would range from very little to eight pounds per day depending on the condition of the bull and the number of services.

Faulty management reduces the efficiency of many bulls. Inadequate stable facilities, no exercise yards and lack of safety measures make the care of the bull a difficult and oft times dangerous task. Nevertheless a bull should get exercise, fresh air and during the summer some green feed. If a bull is



Do not overlook the feet — Note the condition of these feet.



The same feet correctly trimmed.

regularly kept on a farm some provision should be made for a strong safe box stall with an adjoining well fenced exercise yard. This type of equipment reduces the need for handling to a minimum. Over-feeding may render a bull impotent but gross under-feeding is the more common cause. Keep the feet in proper shape, watch for worn or weakened rings and never handle the bull with a weak staff or a frail lead rope. Do not abuse but never trust a bull.

MILKING PROCEDURE

Feed and Milk Quality

There is no evidence that any feed or combination of feeds will increase the butterfat test for an indefinite period of time. Prolonged under-nutrition will tend to lower the test and when this condition is rectified an improved test will be noted. This is a return to the normal level after a period of low test. Sudden changes of feed may cause fluctuations.

Feeds may cause off flavour in milk. Turnips, some silages and green feeds are common offenders. Give troublesome feeds after milking and remove from the offending pasture a few hours before milking. Immediately removing the milk from the stable and rapidly and adequately cooling it will help to prevent undesirable flavours.

Milking Technique

Careful hand milking or skilful operation of the machine is essential for good milking and the maintaining of udder health. The machine lines should be kept clean, inflations properly adjusted and free from cracks or holes, vacuum maintained at the proper level and the speed of the pulsations adjusted to the manufacturers' instructions. The machine operates twice daily on delicate tissue and should receive more detailed care in both maintenance and operation than a piece of ordinary farm machinery.

Dr. W. E. Petersen, an eminent authority on milking procedure, gives five rules as guides for proper milking:

- Rule 1: Avoid excitement of cows either before or during milking.
- Rule 2: Stimulate let-down about one or two minutes before milking is to begin. The most effective stimulus is a vigorous massage of the teats and the lower part of the udder by a cloth taken out of water as hot as the hands will stand.
- Rule 3: In hand milking use the full hand grasp of the teat. In machine milking operate the milker according to the directions of the manufacturer and see that it is in good working order.
- Rule 4: Begin stripping as soon as the teat cups crawl upward.
- Rule 5: Remove the milker as soon as the milk stops flowing.

Butterfat Tests

All cows vary in butterfat test and an individual test of a milking during a lactation period may range from near two to over eight per cent but despite this wide range there is a tendency for the tests to remain near an average. One test may be definitely misleading in determining the average production of a cow but tests made at intervals throughout the lactation period do give accurate information on the ability of the cow to produce fat.

Herd tests are often lower in the late winter and early spring than at other seasons of the year. The low period of test in the lactation is about six to eight weeks after freshening. There is a slight lowering in test as a cow reaches maturity. Tests made on three times a day milking are more uniform than those in twice a day milking. Mastitis tends to lower the test. Digestive disturbances, oestrus, extreme temperatures and any sickness may cause wide variations with one extreme often followed by another in the opposite direction. Rapid milking tends to increase the test; very slow milking lowers it.

The first drawn milk is quite low in fat, testing less than one per cent while the last of the strippings may test as high as eight or ten per cent. Complete and rapid milking enables the dairyman to get all of the milk and particularly the last-drawn high-testing portion. Milk secretion is a continuous process until udder pressure commences to build up, this lowering the rate of secretion eventually stopping it completely. This condition explains why heavy yielders may produce more when milked three times per day while with cows not in full flow of milk there is but slight response to increased times of milking.

HERD HEALTH

Ontario dairy cattle are among the healthiest in the world. Through the protection afforded by the Animal Contagious Disease Act and the veterinarians of the Health of Animals Branch who administer it, dairymen have been spared the plagues which make an efficient industry difficult if not well nigh impossible in many parts of the world. Great progress has been made in the fight against tuberculosis and the loss caused by brucellosis has been considerably reduced in recent years. But much remains to be done; in fact the fight against disease can never end. Disease still costs dairymen millions of dollars annually, a great part of which could be prevented. Admittedly there are diseases which cannot be combatted with full effect without more knowledge, and that knowledge can be gained only through research. For most diseases, however, methods of prevention and adequate treatments are at hand. In this bulletin, symptoms and control measures are indicated for some of the diseases which occur, or could occur, in Ontario dairy cattle. Success in diagnosis, treatment and prevention must be a co-operative effort between the herd owner and his veterinarian.

Mastitis

The term mastitis means inflammation of the udder regardless of the cause. However, in practice, mastitis is almost invariably due to bacterial infection, which gains entrance to the udder by way of the teat opening. It differs, however, from most of the infectious diseases in that it may be caused by any one of a number of bacterial species. These may cause an acute attack with heat, pain and swelling of the udder and leading occasionally to the death of the cow. More frequently the infection will lie apparently dormant for weeks or even months with infrequent acute flare ups. Gradually the secreting cells of the udder are replaced by hard fibrous tissue resulting in diminished quantity and quality of milk. It is through impaired function rather than death loss, that mastitis exerts its most destructive action but together they make it by far the most expensive disease with which the Ontario dairymen must contend.

The most common bacterial cause of mastitis, *Streptococcus agalactiae*, can live indefinitely in the udder of an infected cow but will usually die within a few weeks in other locations such as around the stall, on milk stools or on the hands or clothing of the milkers. These facts, along with the success which has been attained in freeing udders from this organism through the use of antibiotics, point to the possibility of removing this infection completely from whole herds or even wider areas by a well-planned and executed attack. However there are other bacteria capable of causing mastitis, some of which cannot be eliminated from the environment of the cow by practical means. Mastitis control must, therefore, be a continuous process attacking the sources of infection, blocking the avenues by which it is spread and reducing the environmental factors which tend to activate the disease.

Attention to the following points will assist in controlling mastitis:

1. *Have milk samples from all cows in the herd examined in a laboratory.* Identification of infected cows is necessary before the disease can be controlled effectively. Repeated sampling may be necessary to check the result of treatment. Samples submitted by veterinarians are examined without charge in laboratories maintained by the Ontario Department of Agriculture.



Early mastitis infection may be detected through the use of the strip cup.

2. *Have infected cows treated.* Recently infected cows respond well to treatment. Cows showing extensive fibrosis (hardening) of the udder should be sold for slaughter. If valuable as brood cows, they should be removed from the milking line.
3. *Milk infected cows last.* Infection may be spread by the machine or on the hands of the milker.
4. *Feed infected cows carefully.* Heavy feeding can aggravate an existing infection.
5. *Use correct milking procedures.* Speed and cleanliness are of first importance. (See Bulletin No. 484)
6. *Prevent udder injuries.* Adequate bedding, properly constructed stalls or loose housing and dehorning all help in this connection.
7. *Treat teat sores promptly.* They often harbor mastitis producing bacteria. Application after milking of an ointment containing sulfonamides or antibiotics will usually keep down infection and promote healing.
8. *Use a strip cup daily.* Cows giving flakes or clots in the milk can be detected at a stage when treatment is effective.
9. *Keep cows and barns clean.* Many mastitis producing bacteria live in filth.
10. *Prevent calves from sucking one another.* This breaks down the seal which closes the teat canal and may introduce infection leading to mastitis.
11. *Do not introduce infected animals into the herd.* Have the udders of all newly purchased cows examined and their milk tested before they enter the milking line.

Tuberculosis

Great progress has been made in the elimination of tuberculosis through area testing. The Restricted Area Plan now covers all inhabited territory east of the Great Lakes and the remainder of the country is rapidly being covered. Under the regulations of this plan, all areas established for the eradication of bovine tuberculosis are designated as "restricted area." When the incidence of tuberculosis in such an area has been reduced to .5 per cent or less, by testing all cattle therein and the slaughter of reactors, the area is called an "accredited area." Accreditation lasts for three years after which a retest is necessary. Individual herds may also be accredited but in recent years the emphasis has been placed on area testing.

While the incidence of tuberculosis among Ontario dairy cattle has been reduced to a very low level, continued testing is necessary to stamp out new infections which occur from time to time. Inquiries concerning the tuberculosis eradication program should be addressed to your nearest Sub-district Office, Health of Animals Branch, or the District Office, Health of Animals Branch, Canada Department of Agriculture, 366 Keele Street, Toronto, Ontario.

Foot-and-Mouth Disease

Until the outbreak in 1952, foot-and-mouth disease was of only passing interest to Canadian cattlemen. They now realize that it can happen here and that it can have a very serious effect on the whole livestock industry.

It is an extremely contagious virus disease which causes blisters and ulcers to form in the mouth and on the tongue, around the feet and, sometimes, on the udder. It affects only cloven footed animals. In most outbreaks the death rate, due to the disease itself, is low but there is a serious loss of flesh and milk and permanent crippling is not infrequent. If unchecked, an outbreak soon becomes an epidemic. Since infection does not produce permanent immunity and vaccination protects for only a few months, there is no doubt that the continued existence of the disease in this country would, in itself, be equivalent to a tax of many millions of dollars annually on the livestock industry.

The policy adopted by this country and the United States is to contain an outbreak by an immediate and rigid quarantine, slaughter all affected and exposed animals with compensation to the owners and to disinfect the infected premises. In this century six outbreaks have been stamped out in the United States through the use of this method and there can be no doubt as to its effectiveness when rigorously applied. When a cattle owner observes symptoms suggestive of foot-and-mouth disease he should inform his local veterinarian or nearest representative of the Health of Animals Branch, Canada Department of Agriculture, immediately.

Calf Scours

Diarrhoea in calves is largely a result of feeding errors and is seldom encountered when the rules mentioned in the section on calf feeding are observed. When uncomplicated cases occur, it is good practice to administer an ounce or two of castor oil, omit a feed of milk and restore the calf to full feed gradually over a period of several days.

Occasionally, outbreaks of infectious scours occur which may result in a high mortality. Calves are born apparently in good health but become ill during their first week. Scouring is usually a symptom although some calves may die without scouring. Death may occur within a few hours or the calf may last several days. Few untreated cases recover.

On farms where this disease exists, it is particularly important to have the calf born in a disinfected calving pen. In addition, dosing with appropriate sulfonamide drugs or antibiotics, starting immediately after birth and continuing for four or five days, will help prevent the disease. Attention to the nutrition of the dam, particularly with reference to vitamin A, may help build resistance to scours in the newborn calf.

Calf Pneumonia

Pneumonia (inflammation of the lungs) is one of the common reasons for death loss among calves. While bacteria and viruses play a part, its primary cause is generally thought to be inadequate stabling facilities, particularly dampness and poor ventilation. It may also be caused by careless drenching, causing medicinal material to pass down the windpipe into the lungs. Some cases occur as a sequel to prolonged scours.

As a rule the age group principally affected is from one month to three or four months. The most evident symptoms are high temperature, discharge from the nostrils and rapid labored breathing. Until sulfonamide and antibiotic therapy became available, the death rate was high among affected calves. Now early treatment saves the majority although cases which become chronic usually prove fatal.

Since the disease tends to spread, affected calves should be segregated immediately. It is advisable to break up the remaining calves into smaller groups as a means of avoiding overcrowding and further spread of the infection. Bacterins are of uncertain value. Probably the most important factor in preventing calf pneumonia is to provide proper ventilation and thus minimize dampness and draughts.

Foot Rot

Foot Rot is the most frequent cause of lameness among cattle in Ontario. It occurs most frequently when cattle at pasture have access to mud holes or are forced to walk through mud to obtain drinking water. However, it may occur among cattle stabled in apparently excellent conditions. The disease is caused by infection penetrating the skin around the top of the hoof or between the claws. Open sores are formed when portions of skin slough away. Occasionally infection invades the deeper structures and gets into one or more of the joints of the foot. These cases heal with difficulty and may even cause the death of the animal.

Individual cases should be kept in a dry place and treated promptly. Some recover rapidly if the foot is kept clean and treated with mild antiseptics or healing oils. The injection of soluble sulfonamide drugs into the blood stream or antibiotics into the muscle are the treatments preferred by most veterinarians.

If the disease becomes a herd problem, placing a trough containing a coal tar disinfectant solution so that the cattle are forced to walk through it once or twice a day will keep down the number of new infections.

Warts

Warts are unsightly growths which appear most frequently around the head and neck of young cattle or on the teats and udder of milking cows. They are mildly infectious and show some tendency to spread from animal to animal. Large warts may attain a weight of a pound or more and, if in an exposed place, become so raw and painful as to interfere with growth and development. Small warts on cows' teats interfere with milking.

Warts sometimes disappear without treatment after a few months. If they are numerous, their disappearance will be hastened by twisting or clipping a few off, painting the spot with tincture of iodine and softening the remainder every three or four days with oil. Veterinarians sometimes use a vaccine prepared from wart tissue in obstinate cases.

Ketosis (Acetonemia)

Ketosis is one of the most serious disease problems confronting dairymen in this province. In many herds it causes heavy financial loss each year, particularly during the winter months, through lowered production, off flavoured milk and occasional deaths.

Ketosis is not always a separate disease but may occur as a complication. In these cases it would appear that the primary disease causes a drop in appetite which in turn brings on ketosis. Experimentally, it can be produced in a high yielding cow by starvation and no doubt some field cases are due to inadequate amounts of feed. However, many cases occur when no primary cause can be determined and it is generally assumed that a deficiency of some specific substance or substances is responsible. On some occasions cobalt deficiency has been associated with ketosis but this cannot account for all cases.

The condition is characterized by a high level of ketone bodies (fat breakdown products) and a low level of sugar in the blood. This indicates a switch from carbohydrates to fat as the principal source of energy for the cow and it appears to be the essential feature of the disease. This excessive burning of body fat causes rapid loss of condition and frequently this is the first symptom observed, along with partial loss of appetite and lowered milk production. A peculiar sweetish odor may be noted from the breath and the milk. A degree of constipation usually accompanies the condition. Severely affected cows may be dull and depressed although occasionally nervous symptoms such as licking the manger or fore legs, staggering or even convulsions have been observed. These nervous symptoms are definitely exceptions to the rule in Ontario.

In treating ketosis, practising veterinarians generally use glucose or other agents intravenously and most cases respond favourably within a day or so. Cortisone is reported to be an effective treatment but its scarcity and high cost make its use impractical except for very valuable cows. If a veterinarian is not available, a drench of Epsom salts (1 lb.) followed by a pound or more of sugar twice daily and a tablespoonful of cobalt solution (prepared by adding 1 ounce of cobalt sulfate to a gallon of water) once daily may bring about improvement in some cases. In addition, forced exercise, as provided by walking the cow for an hour or more each day, appears to be of benefit.

It is not possible at present to formulate a program of prevention which will be completely effective. However, the following points may assist in preventing the condition: (1) The practice of cutting off concentrates entirely for some days after calving is dangerous — energy should be supplied for current production. (2) Be sure that the ration is adequate in respect to both amount and composition. (3) Observe high producing cows closely since any slight upset may give rise to ketosis. (4) Daily exercise may help reduce the problem. (5) When ketosis is suspected, have the cow examined and treated promptly by your veterinarian.

Milk Fever

Milk fever is one of the most common diseases of dairy cows. It is not a fever — on the contrary, affected cows usually have an abnormally low temperature. It occurs most frequently within the first 48 hours after calving and

is evidenced by a progressive paralysis leading to complete inability of the cow to get on her feet. This paralysis affects the throat making it difficult or impossible for the cow to swallow. *Do not drench a cow with milk fever* because her inability to swallow makes it probable that some of the material will reach her lungs and cause pneumonia. An affected cow usually shows a kink in her neck or will lay her head around on the flank. Breathing is labored and groaning is common. Untreated cases usually die.

Fortunately the treatment of milk fever through the intravenous use of calcium salts is generally successful. Treatment should be given as early as possible, preferably when the cow first shows symptoms of unsteadiness on her feet, but may bring about recovery at any stage. An alternative, also generally successful, is to inflate the udder with air. This practice, however, is dangerous unless done with great care because of the risk of introducing mastitis germs.

Practical and dependable measures for the prevention of milk fever are lacking. The following are sometimes suggested:

1. *Feeding extra calcium.* Although cows with milk fever show a very low blood calcium level, feeding high levels of calcium before calving does not appear to be effective in preventing the condition.
2. *Injection of calcium salts intravenously or subcutaneously immediately after calving.* This will undoubtedly help prevent the condition but is hardly practical as a routine procedure. It is recommended in dealing with cows having a history of repeated attacks.
3. *Incomplete milking for two or three days after calving.* This may be of some value but it is dangerous if mastitis infection exists in the udder.

Bloat

The term bloat refers to an excessive accumulation of gas in the paunch. Bloating is a common symptom of digestive upsets and may be due to a variety of causes. It occurs in its most dangerous form among cattle grazing on lush pasture, particularly one that contains a high proportion of legumes, and under these conditions may cause heavy death loss. Not all legume pastures cause bloat and the reasons why some do are not completely understood. However, pastures either growing rapidly or wilted by drought after a period of rapid growth appear to be especially dangerous. A deficiency of soil phosphorus may also be a factor.

The relief of bloat may require the use of a stomach tube or operative procedures, in severe cases. An ounce of turpentine or a half-ounce of formalin shaken up in a pint of milk and given as a drench may be helpful in simple cases but drenching should be done slowly and carefully. Placing a gag in the mouth, standing the animal with the front quarters elevated and kneading the rumen with the fist all help to expel gas.

Recognition of the following points may be helpful in preventing pasture bloat:

1. Mixtures of grasses with legumes cause much less bloat than legumes alone. Practical tests show that serious bloat rarely occurs if grasses make up at least 50% of the mixture.
2. Supplemental feeding of hay in drylot at night will reduce the incidence of bloat on legume pasture. Feeding hay on pasture may also help.
3. Grass pasture at night will help prevent bloat on legume pasture the next day.



Vaccination cuts down losses from Brucellosis.

Abortion

Contagious abortion (brucellosis) is still widely distributed in Ontario although its effects are being countered by vaccination. Symptoms of infection include premature calving, retention of the afterbirth and subsequent sterility. Although the organisms usually localize in the udder or womb, on occasions they affect the joints, especially the knee and stifle. The site of infection in bulls is usually the genital organs.

A positive diagnosis of brucellosis in a breeding herd may best be established by having blood samples tested in a laboratory. While occasional early infections are missed by this test, it is in general a reliable method of determining whether or not the infection exists in a herd or in an individual animal.

This disease is frequently brought into clean herds by the introduction of one or more infected animals. It is spread within the herd by the discharges of infected cows contaminating pasture or foodstuffs of other cattle. An infected bull may also spread the disease at the time of service.

Most control programs are based on calfhood vaccination which if practiced when calves are six to eight months of age produces a serviceable immunity. In Ontario, the vaccination of female calves is compulsory in townships that have been designated supervised areas under the Brucellosis Act, 1956. In each of these townships the cost of vaccination is borne by the Province. Vaccination is voluntary in other townships and where that situation prevails the owner is obliged to pay for the service.

On October 1st, 1956, the date on which the Brucellosis Act, 1956 came into force, 245 townships were designated supervised areas. Other townships may be added to this list upon receipt of petitions bearing the signatures of at least two-thirds of the cattle owners. Even so, Ontario has already moved far in the direction of controlling this disease.

It must be remembered that brucellosis is not the only cause of abortion in cattle. *Trichomoniasis* caused by a microscopic parasite, is spread by the bull at the time of service and causes abortion and sterility. Similar symptoms are produced by vibrio foetus infection. In both of these infections, abortions tend to occur at an early stage and may be missed by the owner. Where widespread sterility exists in a herd, along with occasional abortions, the condition should be thoroughly investigated since one or more of a number of causes may be operating.

Breeding Problems

Sterility or delayed breeding is a problem of increasing concern to dairymen. It is a complex problem arising from many causes and not, therefore, capable of quick solution. Like mastitis it is a continuing problem and requires a continuing program to combat it.

Suggested measures to improve breeding efficiency in the dairy herd are as follows:

1. Keep accurate and complete records of dates of heat, breeding, calving or abortion and unusual symptoms. Such records are of great value in arriving at a diagnosis in case of trouble.
2. Give cows a rest of at least 60 days after calving before breeding.
3. Do not breed a cow showing an unnatural discharge.
4. Isolate aborting cows until all discharge has ceased.
5. Consult a veterinarian if a cow does not conceive following three services to a fertile bull.
6. Owners of valuable breeding herds find it pays to have the breeding health of the herd checked at regular intervals by a qualified person. Regular pregnancy diagnosis is an important part of such a service.
7. Do not discard a cow because of sterility before having her examined for pregnancy.
8. If infertility is widespread in the herd be sure to check the herd sire.

Parasitic Diseases

The majority of cattle parasites in Ontario may be readily kept under control by sound farm management practices, proper sanitation and regularly applied preventive treatments.

The most serious parasites with which the dairyman has to contend are the warble flies and their grubs. These insects, if neglected, will cause loss of weight through making animals gad and their grubs may do extensive damage to carcasses and hides. The control of warbles, however, is well organized in the Province and is conducted on a community basis in many townships, which upon petition of two-thirds of the cattle owners, have passed by-laws requiring all cattle to be treated in accordance with the Warble Fly Control Act. In other areas, not under the Act, they are treated individually, as recommended in the regulations made under the Act. The hand dressing consists of one pound cube of derris powder containing 5% rotenone or its equivalent to one gallon of water. It is applied with a stiff brush to the backs of cattle in April and May.

"Barn itch" may unnecessarily cause unthriftiness in herds especially during the winter months. This condition is commonly caused by lice, at other times by ringworm or mange mites, either alone or collectively. Regular inspections of animals and routine use of standard dusting powders for lice, will keep herds free from these pests. Suspected cases of mange should be

reported immediately to local representatives of the Health of Animals Branch, Canada Department of Agriculture, who will insure action is taken to prevent the spread of this disease.

Internal parasites (including worms coccidia and other protozoans) although they do become established in certain herds, are relatively unimportant in Ontario. High standards of sanitation, ample pastures, manger feeding and the use of properly constructed watering troughs will do much to keep disease caused by these parasites under control. Young animals, as far as possible, should be segregated from older stock.

Disinfection

The contamination of bedding, floors, stalls and yards by the discharges of infected animals is the principal means by which an infectious disease is spread.

To destroy infection, all bedding and manure accumulating from sick animals should be burned or spread thinly on ground to which other animals do not have access. Stalls and floors should be thoroughly cleaned and disinfected.

Chemical Disinfectants

- Lye — 1 pound to 20 to 30 gallons of boiling water.
- Creolin — 2% solution.
- Liquor cresol compound U.S.P. — 2 to 3% solution.
- Carbolic acid — 3 to 5% solution.
- Bichloride of mercury — 1 part to 1,000 parts of water by weight.
- Other disinfectants — use according to manufacturers' directions.

As a rule chemical disinfectants are more effective when used hot. This is especially true of lye which is a cheap and effective disinfectant against most disease organisms.

SOLUTIONS	IN 1 QUART OF WATER	IN 1 GALLON OF WATER
2% solution	6 teaspoons	3 ounces
3% solution	2½ tablespoons	4½ ounces
4% solution	3 tablespoons	6 ounces
5% solution	3½ tablespoons	7 ounces

Fly Control on Cattle

While horn flies are the most common insect pests of cattle on pasture, other species of “biting” flies are not uncommon. All species cause the animal discomfort and their activities result in reduced milk and butterfat production and smaller gains in weight.

Horn flies are small, dark gray flies about half the size of house flies. They always rest on cattle with the head-end down and are most numerous over the withers. Except when laying eggs, they do not leave the animals. These pests develop only in fresh cow “pads”. *Stable flies* or so-called “biting house flies”, resemble the common house fly in size and coloration. They develop in wet straw or strawy manure and breeding is continuous during the summer months. *Tabanid flies* include the large black horse flies and the smaller moose and deer flies. They develop in moist soil at the edges of streams and ponds and in swampy areas. On farms where these conditions exist, tabanids are frequently numerous.

Control

The protection of cattle from biting flies is a difficult problem and until recently nothing was available that would give other than temporary relief.

Satisfactory controls include: *treatment of individual animals* with insecticides (spray, dust, or aerosol) which retain their repellent and toxic properties for some time, ready-to-use *space sprays* shortly before milking, and two *self-treatment devices* — insecticide-treated “backrubbers” and automatic treadle-sprayers.

A. SPRAYS, DUSTS AND AEROSOLS ¹

A *spray* prepared from:

50% methoxychlor-wettable powder	1 lb.
Water	12 gallons

and applied with a wheelbarrow, knapsack, compressed-air, or power-sprayer, will give up to three weeks' protection. The animals should be wetted thoroughly.

There are several commercial oil-base products ² containing pyrethrum and piperonyl butoxide, thiocyanates, etc., available. Any of these, used before milking, provides a quick “knockdown” of flies which have come in with the cows but has little lasting effect. These oil-base sprays should be applied with a small atomizing sprayer as a mist over the animals or on the outer hair only. Animals must never be soaked with any oil-base spray.

The *dusting* of each animal with:

50% methoxychlor-wettable powder	2 to 3 tbsp.,
----------------------------------	---------------

lightly rubbed in, will give protection from horn flies, and to a lesser extent from the larger biting flies, for two or three weeks. Rains may shorten this period.

Commercial *aerosol* oil-base preparations for treating animals are also available. The same precautions as mentioned two paragraphs earlier should be observed.

¹ Certain insecticides, such as DDT, should never be applied to milking cows or to beef cattle within two months of slaughter.

² When using, follow directions provided by the manufacturer.

B. SPACE SPRAYS AND AEROSOLS

Several kinds of safe space sprays for killing flies in loafing barns and other farm buildings are available. Excellent control can be obtained with oil sprays or emulsions containing pyrethrum and piperonyl butoxide, thiocyanates, etc., applied as a fine mist from hand-operated sprayers or electric machines. Aerosols containing these insecticides will give a good fly control job also. With both the space sprays and the aerosols, applications must be made at least once each day except where sanitation is excellent. These sprays only kill the flies which are hit by the fine droplets of insecticide.

C. SELF-TREATMENT DEVICES

“*Back-rubbers*” are particularly useful for repelling and controlling horn flies on young stock and beef animals on pasture. A piece of heavy chain wrapped tightly with several layers of burlap, and stretched on a slant from the bottom of one post to the top of another 7 or 8 feet away, will provide a simple, inexpensive and effective “back-rubber”. Periodically the burlap should be treated with the mixture described below:

25% methoxychlor-emulsion concentrate	1 gallon
Water	4 gallons

Stir vigorously and then dilute 1 part (by volume) in 4 parts of fuel or diesel oil. Used crank-case oil is not recommended for this purpose; in hot weather it may cause injury. If located in a part of the pasture where the cattle gather for rest, feed, water or salt, most animals will treat themselves, when they rub against the treated burlap. Back-rubbers may be purchased ready to install or may be homemade.

Automatic treadle sprayers have been in use in several of the middle western states for some time. These enable cattle on pasture during the "fly months" to treat themselves with spray. Where installed properly and serviced regularly with a suitable insecticide, they control biting flies very satisfactorily. The treadle sprayers work best in pastures with a single water source which can be fenced off. A unit is installed in a gap in the fence so that cattle must pass through it to get water. One side of the animal is sprayed as it goes through to water, the other as it leaves. A unit could readily be set up in a lane between the pasture and the farm buildings. Cattlemen, interested in this type of automatic sprayer, should write to the Department of Entomology and Zoology, O. A. C., for plans and further information.

House Fly Control in Stables

The house fly is the most common fly in dairy barns. Control has proved very difficult on some farms because, in these cases, strains of house flies have developed which are resistant to some of the present-day insecticides. Other important factors in control such as sanitation must not be ignored since no insecticide can be expected to be effective if more or less permanent breeding areas are in or near the barn.

Control

A. SANITATION

Sanitation is the *most important* method of fly control. Eliminate the breeding places. Under ideal conditions flies may develop from egg to adult in ten days.

Remove the manure from stables once every day — not only from the gutters but from the calf pens as well. On many farms the manure is left to accumulate in calf pens for weeks. Under these conditions flies by the hundreds and thousands may emerge daily. Every four or five days the manure should be taken to fields and spread thinly.

If the manure must be stored for a time before spreading, have only one pile. A well-drained concrete floor or platform under the pile will permit all-weather hauling-out. Keep the edges of the pile as steep as possible. If swine and poultry are kept, attention should be given to their manure as well.

Screen milk houses, stables and piggeries, if at all possible. The window screens and screen doors should fit snugly and the screening must be sound. Screen doors should always open outwards.

B. CHEMICAL CONTROL OF ADULT FLIES

With any method of insecticidal control in stables, great care must be used to prevent the poison from contaminating mangers, feed bins, watering devices, hay, or any surfaces that cattle may lick. Remove all animals from the stable before a residual insecticide is applied and keep them out for three or four hours.

1. Residual Surface Sprays

This type of control leaves a poisonous residue on treated surfaces that will remain effective for some time. Insecticides may be applied with a small power-sprayer (reduce pressure to prevent misting) or with a hand-sprayer of the wheelbarrow, knapsack, or 2- to 3-gallon compressed air type. Wet the surfaces treated (walls, ceilings, about windows, doors, and other places where flies rest) to the run-off point. One gallon of spray should cover about 1,000 square feet of surface.

If one of the following insecticides has given satisfactory control in the past or if insecticides have never been used before, use any one of the products listed below:

50% DDT — wettable powder	1 pound in 5 gallons of water
25% DDT — emulsion concentrate	1 quart in 5 gallons of water
50% methoxychlor — wettable powder	1 pound in 5 gallons of water
25% methoxychlor — emulsion concentrate	1 quart in 5 gallons of water
25% lindane — wettable powder	1 pound in 5 gallons of water

If difficulty has been encountered in controlling flies with the chemicals mentioned above, one of the following sprays is recommended:

25% malathion — wettable powder	2 pounds in 5 gallons of water
50% malathion — emulsion concentrate	1 pint in 5 gallons of water
25% Diazinon — wettable powder	2 pounds in 5 gallons of water
25% Diazinon — emulsion solution	1 pint in 5 gallons of water

Diazinon preparations are particularly hazardous to use from the standpoint of both the operator and livestock, but treated surfaces will remain toxic for as long as from 4 to 6 weeks. Malathion is less dangerous to use but its effective period is shorter. Neither should ever be sprayed on livestock. *Read carefully and follow the precautions listed on the containers.*

2. Liquid and Dry Baits

Baits when used alone are helpful but are not as effective usually as residual surface sprays. Frequently both are used at the same time. A number of commercially prepared baits are available. These usually contain either malathion or diazinon.

3. Space Sprays

Sprays containing pyrethrum, pyrethrum mixed with piperonyl butoxide, lethane, thanite or other “knock-down” types of insecticides are effective and safe to use in dairy and other barns. These are sold under manufacturers’ trade names, therefore the label will have to be consulted for “active ingredients” and method of use. These low toxicity products may be used in mist or fog machines.



Single storey milking shelter dairy barn with attached feed storage.

HOUSING THE DAIRY HERD

The proper housing of the dairy herd is an important feature of the sanitary, environmental, and comfort aspects necessary for increased production.

Dairy Barn Types

Two types of dairy barn systems, the stall and loose housing, are now being used in Ontario, and each has merit.

The stall barn is the more common type in Ontario. In this type all the milking cows are housed in the barn at one time and usually a separate stall is provided for each cow. Since many years of practical experience has developed this system and because the dairyman has become accustomed to it, continued use can be expected.

The loose housing system of housing dairy cattle is relatively new. The proper layout consists of five specialized areas — the resting area, feeding area, paved yard, milking area and specialized pen area. Research and practical experience indicates that the animals do well under this type of housing. This system results in the production of a high quality milk, provides a low cost type of structure, and makes possible an assembly line technique in milking.

Materials of Construction

The design of suitable housing for a dairy herd requires careful consideration of the construction materials, for herein lies much of the economy of a new or a remodelled structure. Some of the characteristics of good building materials are sanitation, durability, strength, fire resisting qualities, and thermal characteristics. The general trend in dairy structures is toward light masonry units and light structural framing and this is made possible by using many of the new building materials that are of light construction yet strong and durable.



Conventional type two-storey barn with farm house and farm buildings.

The initial costs and the maintenance costs are of prime importance in constructing dairy buildings and these are largely determined by the materials used in construction. Concrete is one of the better materials since it has a low maintenance cost, is workable in its initial state, is durable, and above all is sanitary.

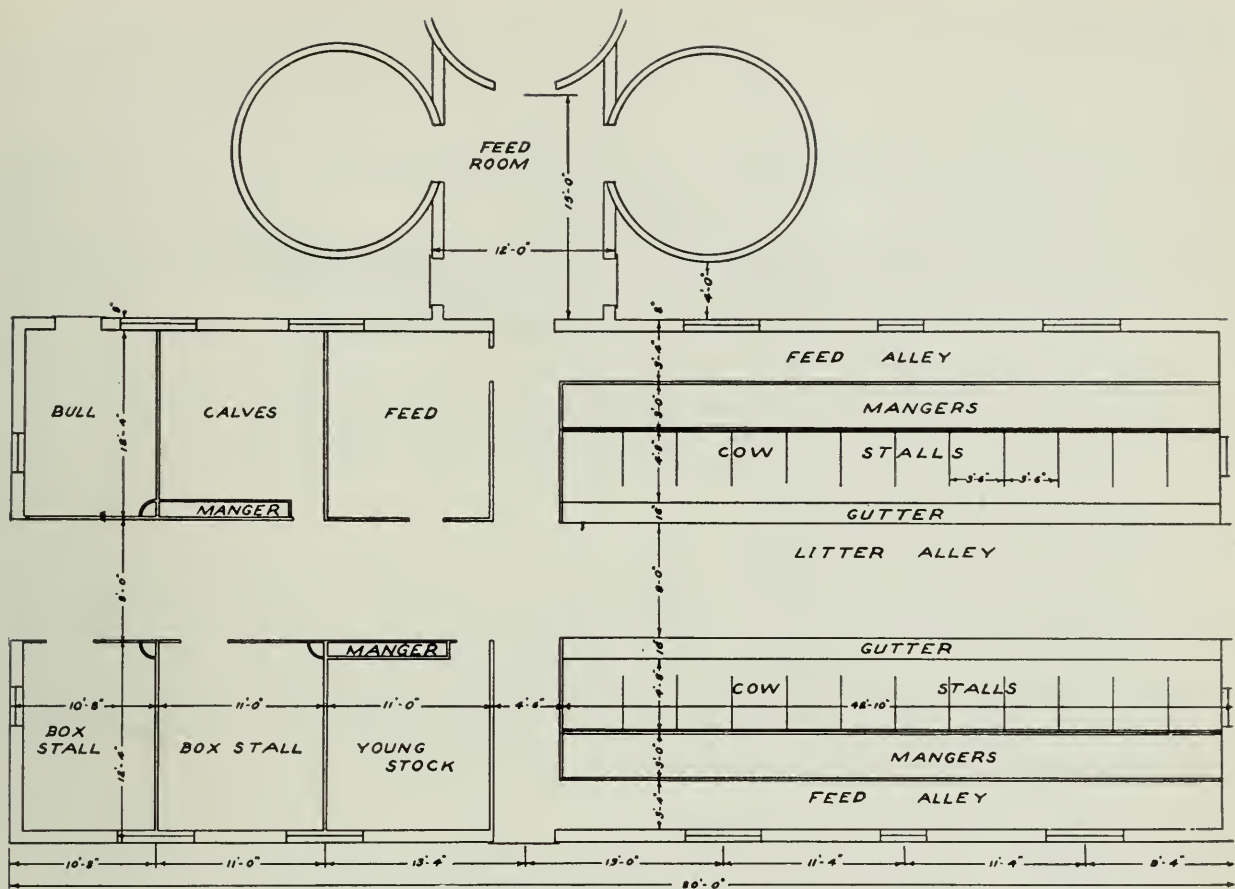
Types of Stall Barns

There are several types and combinations of types of stall barns. Present trends indicate an increased interest in one-storey barns, due in part to the increased use of baled or chopped hay and grass silage. Frequently the old barn can be used for housing the young stock and dry cows, as well as providing storage for roughage and bedding. A new modern dairy barn of one-storey construction may cost little more than remodelling the old barn.

The two-storey structure must have a frame strong enough to carry the weight of a winter supply of hay, grain and bedding for the herd, as well as the loads imposed by wind and snow. Many variations are possible in detailed arrangements but basic design and dimensions have become almost standard. By building the two-storey structure, requiring one foundation and one roof, economies in building costs and labour are secured which are hard to obtain in one-storey construction.

PLANNING THE STALL BARN

A well planned and properly constructed barn saves labour, makes for pleasant working conditions, prevents waste of feed, increases milk production and adds to the comfort of the animals. In planning a dairy barn, there are a number of factors which require special consideration, including sanitation, animal comfort, stall arrangements, stall, manger, and gutter dimensions.



A plan of a typical dairy barn with face-out arrangement. This arrangement allows efficient work behind the cows. The walls are not spattered with droppings, fewer doors are required, mangers are exposed to direct light and more efficient use is made of space for pens, box stalls and feed.

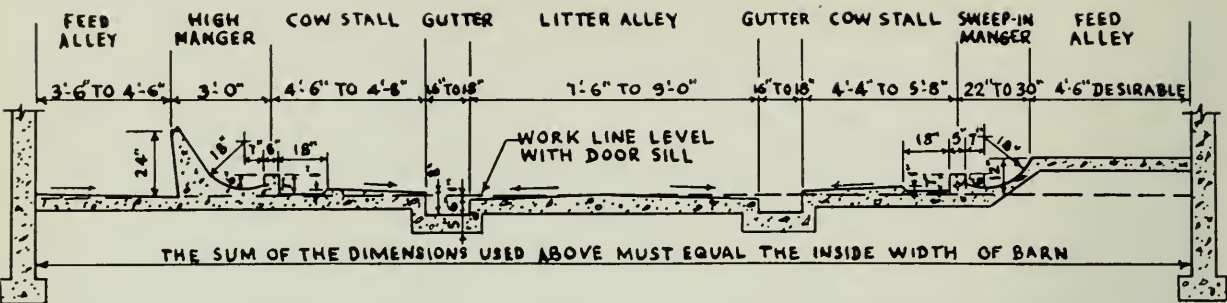
TABLE NO. 11. STALL DIMENSIONS

Weight of Cow	Girth in Inches	Width of Stall	—Length of Stall—
800 lbs.	65	3'4"	4'6"
1000 lbs.	70½	3'8"	4'8"
1200 lbs.	75	4'0"	5'0"
1400 lbs.	79½	4'4"	5'4"
1600 lbs.	84+	4'8"	5'8"

Manger Dimensions

There are two types of mangers — high back and low or sweep-in type. The floor of the manger is raised so the cow feeds from a height of one or two inches above the standing platform. The curb in front of the cow is 6 to 8 inches high, while the front of the manger may be flush with the floor for the sweep-in type, or be raised 24 inches above it for the high front type. The continuous manger should drain to one end to facilitate cleaning and have a slope of one-half inch in twenty feet.

Gutter Dimensions



A section view of face-out arrangement showing recommended dimensions. On the right is shown construction of sweep in manger while on the left is the high manger.

Daylight, Doors and Windows

It is recommended that at least four square feet of window glass area per cow be incorporated in buildings, with three square feet being acceptable in the northern areas. For glass block in place of window, provide 6 square feet of glass area per cow. Sliding doors are generally recommended for dairy barns with double sliding doors for drive-through central litter alley. Door openings should be 8 feet wide and at least 6 feet 6 inches high.

Feed Storage

TABLE NO. 12. UNIT WEIGHT OF MATERIALS

Material	Weight per cu. ft.
Grains, bulk	lbs.
Barley	39
Corn, shelled	45
Oats	26
Rice	36
Rye	45
Soybeans	48
Wheat	48
Feed, concentrates	
Bran	13
Grains and Supplement mixed	32
Linseed or Soybean meal	30-40
Middlings, loose	25
Feed, roughage	
Hay, bales, loose bales	10
Ordinary bales	12-14
Hay chopped	8-10
Hay long	4-5
Silage	33-50

Approximate tonnage capacities of round silos from top of silo to various depths and average weight per cubic foot of silage.

TABLE NO. 13.

Depth of Settled Silage (in ft.)	——Diameter of Silo——						Average Weight of Silage per cu. ft. lb.*
	10 ft	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.	
	Tons	Tons	Tons	Tons	Tons	Tons	
10	15	22	29	38	49	60	38
15	25	35	48	63	80	99	42
20	35	50	68	89	113	139	44
25	45	65	89	116	147	181	46
30	56	80	110	143	181	224	47
40	....	....	152	198	251	310	51
45	....	....	....	226	286	353	52
50	....	....	....	....	320	396	53

* Average weight in lb. per cu. ft. for all silage above depth indicated.

Ventilation

Adequate ventilation provides a suitable atmosphere within the dairy barn, maintains the health and production of the herd.

Ventilation should —

1. Keep the stable dry.
2. Remove stale air and strong odors.
3. Bring in fresh air without draughts and without making the stable cold.
4. Remove excess heat during the warm spells and maintain a near uniform stable temperature.
5. Draw off excess moisture and thus prevent the deterioration of woodwork, the peeling of the paint and the corrosion of metal parts and electrical fixtures.

Amount of Ventilation Required

The dairy cow gives off considerable body heat which is utilized to keep the stable warm. A stable temperature between 45° F and 55° F with a relative humidity of 75% is the best for the comfort and health of the animals. With outside temperatures below 0° F it requires 25 to 30 cubic feet of air per minute for each 1,000 pound cow to maintain correct stable temperature and humidity. At temperatures between 0° F and 32° F, 40 to 60 cubic feet per minute is required while for temperatures above freezing, 60 to 120 cubic feet per minute is needed.

Since the outside temperature is constantly changing over a wide range a varying volume of air is required to maintain a satisfactory condition within the dairy stable. An exhaust fan, or fans, properly installed and properly located and equipped with a thermostatic control, will maintain a uniform temperature within the stable.



Loose housing system. A low cost type of structure in which chore time is reduced and healthy cattle maintained.

TABLE NO. 14. FAN CAPACITY

No. of Animal Units	—Air Required in C.F.M.—		No. of Fans	No. of Thermo- stats	Size of Fans
	Cold Weather	Weather Warm			
20	600	2000	1	1	600 & 2000 c.f.m. (T)
30	900	3000	1	1	900 & 3000 c.f.m. (T)
40	1200	4000	2	1	1 — 1200 c.f.m. (C) 1 — 2800 c.f.m. (T)
50	1500	5000	2	1	1 — 1500 c.f.m. (C) 1 — 3500 c.f.m. (T)
60	1800	6000	2	1	1 — 1800 c.f.m. (C) 1 — 4200 c.f.m. (T)
90	3000	9000	3	1 or 2	1 — 3000 c.f.m. (C) 1 — 3000 c.f.m. (T)

Animal Unit is a 1000 lb. cow or its equivalent

(C.F.M.) cubic feet per minute

(T) Fan on Thermostat Control

(C) Fan on continuous operation.

PLANNING THE LOOSE HOUSING SYSTEM

The single storey self-feeding type of structure and the remodelled stall barn are two types of construction which are specifically designed for loose housing. However, almost any type can be converted to this system provided the building adheres to certain principles. The building can be uninsulated and should have a housing area of 50 to 60 square feet per cow which does not include the requirement for the feeding area space. The ceiling clearance should be at least 9 to 10 feet to allow the manure pack to build up and the building should be a fairly sound structure. Concrete or masonry walls should be at least 4 feet high.

The pole barn is one type of single storey structure used for loose housing systems and is so-called because of its pole framework. The essential features are the low cost and versatility of the structure. The remodelling of conventional barns to loose housing is the more common in Ontario because of the desire to use existing buildings.

Planning the Loose Housing Barn

The loose housing barn is divided into five distinct areas, each having an important function in the system.

The Resting Area

In the resting area or loafing area the cattle are free to move about and bed down on the pack which is warm and comfortable. Bedding requirements are about 12 pounds of straw per cow per day. Shavings and sawdust can be used but the requirement per cow is almost double that of straw.

Feeding Area

Allow 25 to 35 square feet per cow not including the space required by silage bunks or feed racks. If a combined resting and feeding area is used, allow a total of 75 to 95 square feet per cow. Where feed is stored overhead self feeders can be used and where silage is fed in separate feed bunks, allow 28 inches of length per cow.

Provide an adequate supply of clean, fresh water and make some provision to prevent it from freezing.

Exercise Yard

An exercise yard should be provided outside the bedded area with 50-75 square feet per cow or if unpaved yard 300 square feet per cow. Allow at least one inch slope in 10 feet for proper drainage.

Milk Area

The principle feature of the loose housing system is the milking room which enables one or two operators to handle several cows in relays.

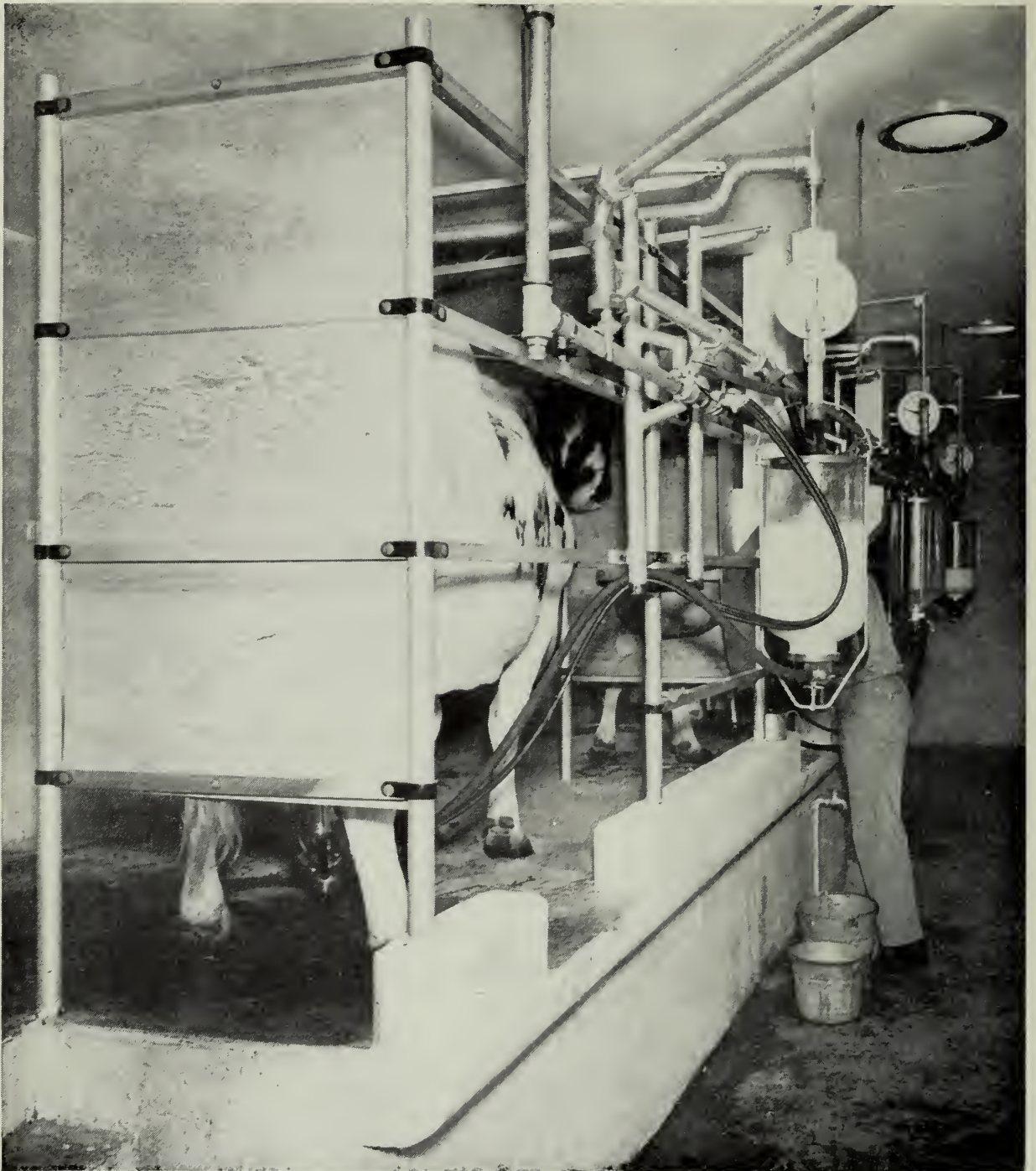
The following recommendations are given:—

1. Locate the milking room so that the doors will open into the resting and feeding areas or into holding pens. This keeps the milked and unmilked cows separate at milking time.
2. Elevate the milking room stalls to a height of 34 inches above the floor to permit the worker to work without stooping.
3. Use mechanical means for opening doors where possible.
4. Install several 6-inch drains to permit easy cleaning.
5. Insulate the milking room so it can be heated economically.
6. Locate the milking room and milkhouse in such a manner that the traffic is cut to a minimum.
7. Arrange the milking room stalls for maximum efficiency. Three to five minutes should be adequate milking time per cow.

Special Areas

While some dairymen permit young stock and dry cows to run with the milking herd, the usual recommendations are to provide separate pens for these animals. Maternity pens may be formed with the use of temporary gates in the bedded area. The pens should be approximately 10 feet by 10 feet.

Calf pens should be close to the milking room to facilitate feeding and watering and should provide 20 square feet of pen space per calf. A separate resting and feeding area may be provided for young stock, close to the cows if possible, to reduce the distance travelled in doing chores, or in a separate shed close to the feed supply. Allow about 30 to 50 square feet of pen space per head.



A modern milking parlor, clean, sanitary, with comfortable working conditions. This milking parlor is located at the Ontario Agricultural College, Guelph, Ontario.

The committee wishes to acknowledge the co-operation given by the Department of Public Relations, Photographic Division, Ontario Agricultural College, Guelph, in securing many of the illustrations in this bulletin.

CA20NAF6
B520

MODERN MILK HOUSES

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

Dr. C. D. Graham
Deputy Minister

Hon. William A. Goodfellow
Minister

FOREWORD

Owing to increased demands for high quality milk production, it has been found necessary to revise milk house construction procedures. Sanitation requirements and adequate space provisions have been the main factors which have influenced design trends in this portion of the dairy industry.

More modern equipment and new methods of handling milk have affected floor plans, and new building materials have given the designer greater scope in providing satisfactory structures with minimum cost.

Many old milk houses have been too small and inconvenient for sufficient cleaning of equipment. Some farmers employing bulk milk tanks needed larger milk houses to accommodate the new methods of storing milk. In any case, a vast number of milk houses are being constructed to conform with government regulations in both can cooling or bulk cooling of milk.

This bulletin is prepared in such a way that the descriptive materials and illustrations are applicable to both bulk tanks and can coolers.

It is hoped that the reader will obtain sufficient material from the bulletin to plan milk houses with a sound knowledge of principles.

Working drawings are available upon request from the Distribution Service, Department of Public Relations, Ontario Agricultural College, Guelph, Ontario. Please order by plan title.

ACKNOWLEDGEMENT

The material in this bulletin has been approved by Everett M. Biggs, Dairy Commissioner of the Dairy Branch, Department of Agriculture, and Dr. A. E. Berry of the Ontario Department of Health.



A well-constructed milk house with gable roof construction. Louvres in the gable end prevent condensation.

MODERN MILK HOUSES

by F. H. Theakston, Professor
Department of Agricultural Engineering
Ontario Agricultural College
Guelph, Ontario

Modern methods of handling milk and increased needs for sanitation have demanded that plans and recommended construction of milk houses be established so that a high quality product may be maintained throughout the dairy industry.

While every farmer will have problems of plans and construction peculiar to his area, basic principles must be followed if the milk house is to perform the required functions.

The functional operations of a milk house and equipment may be stated specifically as:

1. Cooling and storing milk.
2. Cleaning and sterilizing equipment.
3. Storing equipment between milkings.

Four items of equipment must be included in the milk house if an efficient unit is to be established: a milk cooler, a water heater, a double wash vat, and an equipment cabinet or storage rack. A plan, therefore, must be established around these basic requirements; the structural features of the buildings must conform with sound building practices, sanitation requirements, and practical, economical building materials.

Since most progressive farmers plan for the future, proposed structures affecting the milk house must be considered in the planning stage of the milk house. Items such as silos and barn yards may affect the sanitation requirement, and remodelling projects may limit location of the building.

Expansion of the program will necessarily be a factor in milk house construction, and the shape and construction details of the building may prohibit this growth to some extent, for some designs do not lend themselves to changes in size as well as others do.

Generally, there is no building on the dairy farm which requires more careful planning and good workmanship than the milk house. If it is planned properly, a high quality product will be evident, and the farmer will measure his investment against satisfaction, reduced time and labour, and a very sanitary environment in which to store the milk.

Choosing the Best Site for a Milk House

The milk house should be located adjacent to the barn in order that milk can be cooled as soon as possible following milking. Since bacteria may be picked up en route to the cooler, the shortest, most direct route is advisable, but it is recommended that the barn and milk house be separated by a vestibule to prevent direct openings from the barn area to the milk house. Thus, the location of the milk house should be determined after a careful examination of the milking area for the best possible routes of travel. A central location with relation to the dairy barn is most suitable, but with small herds and a central alley the house can be placed at one end.

Odours will be carried from silos and the barnyard into the milk. Since unsanitary conditions will also create a fly problem, it is necessary to build the milk house on the clean side of the barn to limit these hazards. Good drainage is important from the point of view of stability of the structure and sanitation aspects. Therefore, build on high ground even if extra fill is required to increase the elevation. By-pass all farm surface drainage around the milk house and dispose of interior wash water by means of field tile through a catch basin and thence to a disposal field.

Provide enough turning area for milk trucks, and grass the area to limit dust and mud. Circular traffic is desirable since rear-observation is almost nil from most large milk trucks.

If a loading platform is used with a milk house, sloping sites can be used to advantage for more convenient and easier loading.

Since the milk house is the centre of a large amount of the farm work, it should be placed so that the entrances are convenient to the farmer and sheltered from the weather as much as possible.

If a milking room is used on a dairy farm, the milk house should be located to obtain the minimum run of pipeline.

When a milk room is built to satisfy all of the sanitation regulations, the milk house may be incorporated in this structure and a co-ordinated routine can be established. A properly located milk house should assist in simplifying time and labour; therefore, time spent in consideration of the site will pay dividends in the future.

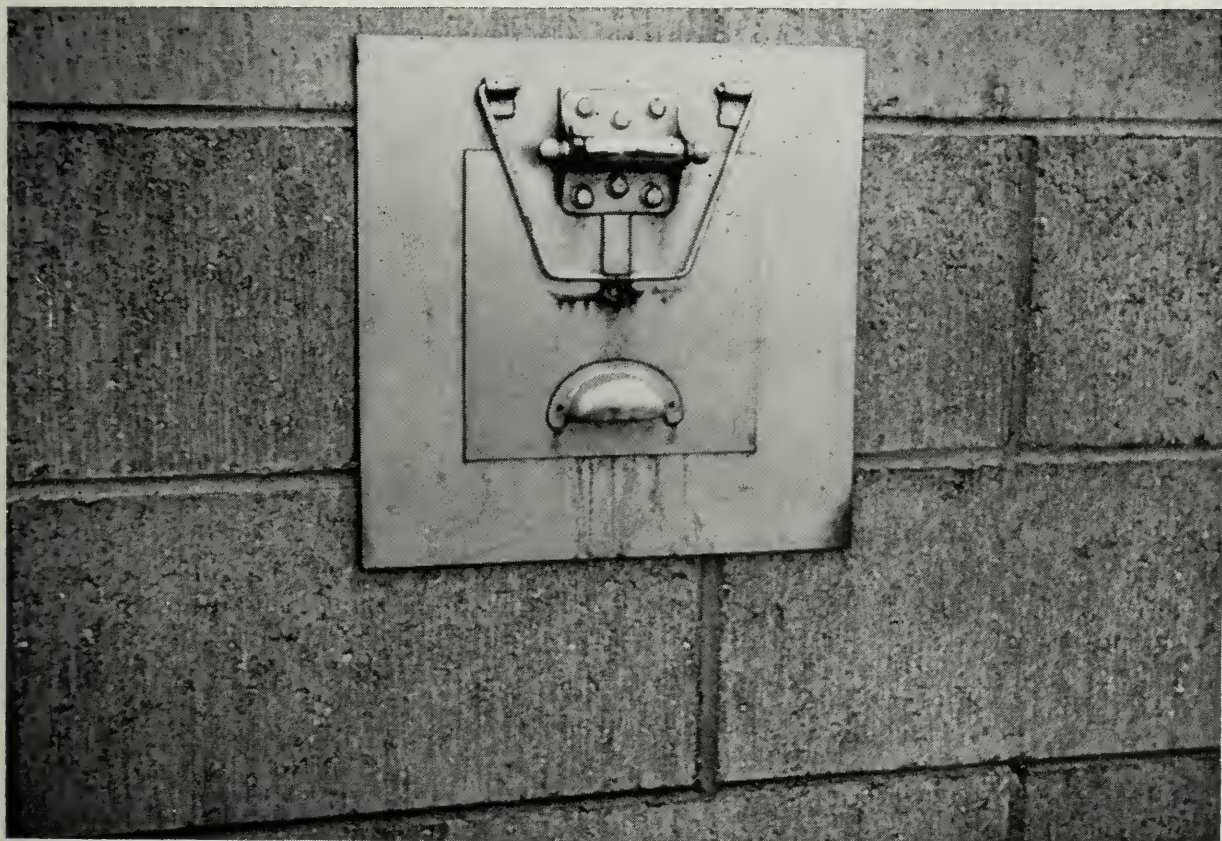


It is not desirable to have the milk truck back into the milk house because rear vision from most trucks is poor.

Selection of the Size

The size of the milk house will depend primarily upon the quantity of milk produced, allowing for future expansion of the dairy enterprise. The minimum interior dimensions are based on bulk tank storage for "skip-a-day pickup".

Since milk is picked up every second day, the dairyman must cool and store two days' milk production. Thus a milk house used for bulk milk will be a little larger than that required for can storage on daily pickup. However, since bulk tank storage is becoming more popular, a farmer presently shipping milk in cans would be advised to build the milk house on the assumption that in the future it may be changed to bulk milk storage.



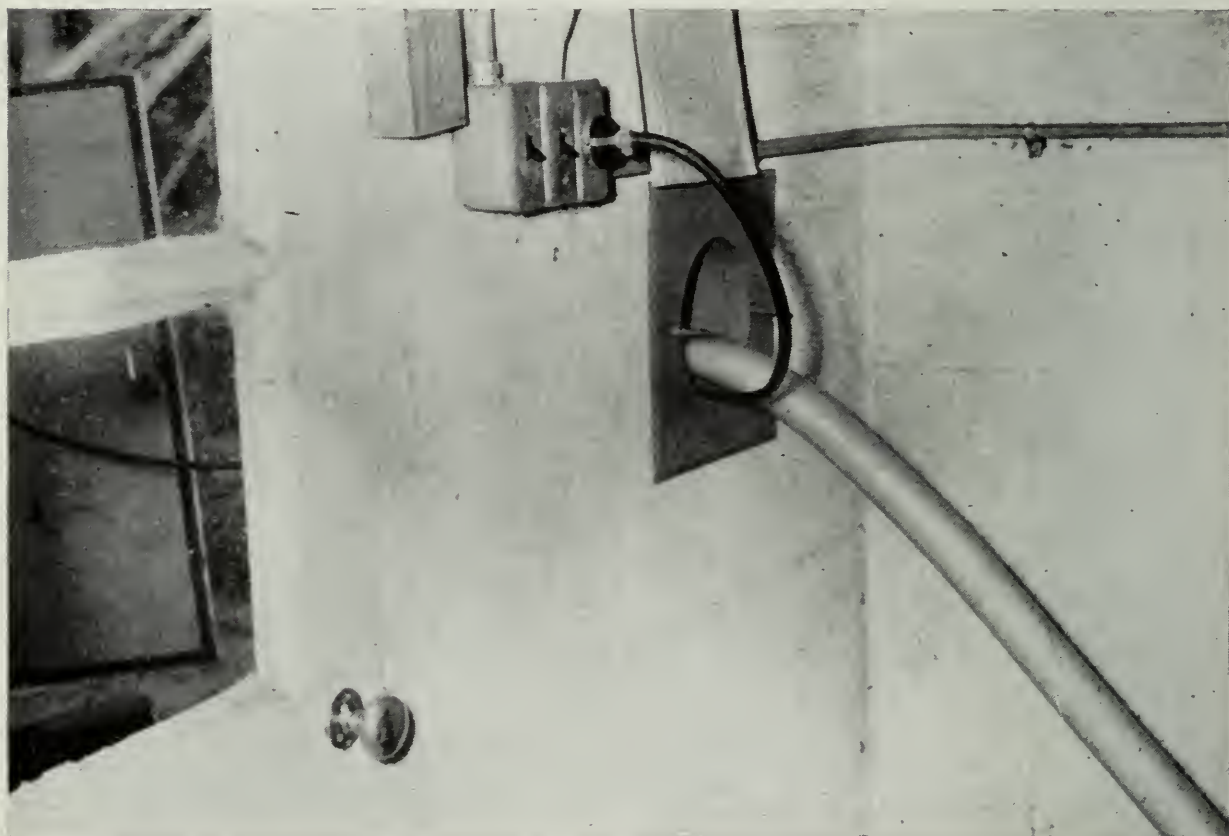
Where bulk tanks are used, heavy steel trap door with spring steel hinges will help keep the milk house sanitary.

Milk House Plans

The location selected for the milk house will influence the plan and equipment arrangement. Regulations under The Milk Industry Act of Ontario also stipulate practices that must be adhered to and that consequently affect the planning of a milk house.

The plans included in this bulletin comply with the regulations established for the production of quality milk. Although these plans are illustrated as annexed to the barn proper, they can be built as structures separate from the barn.

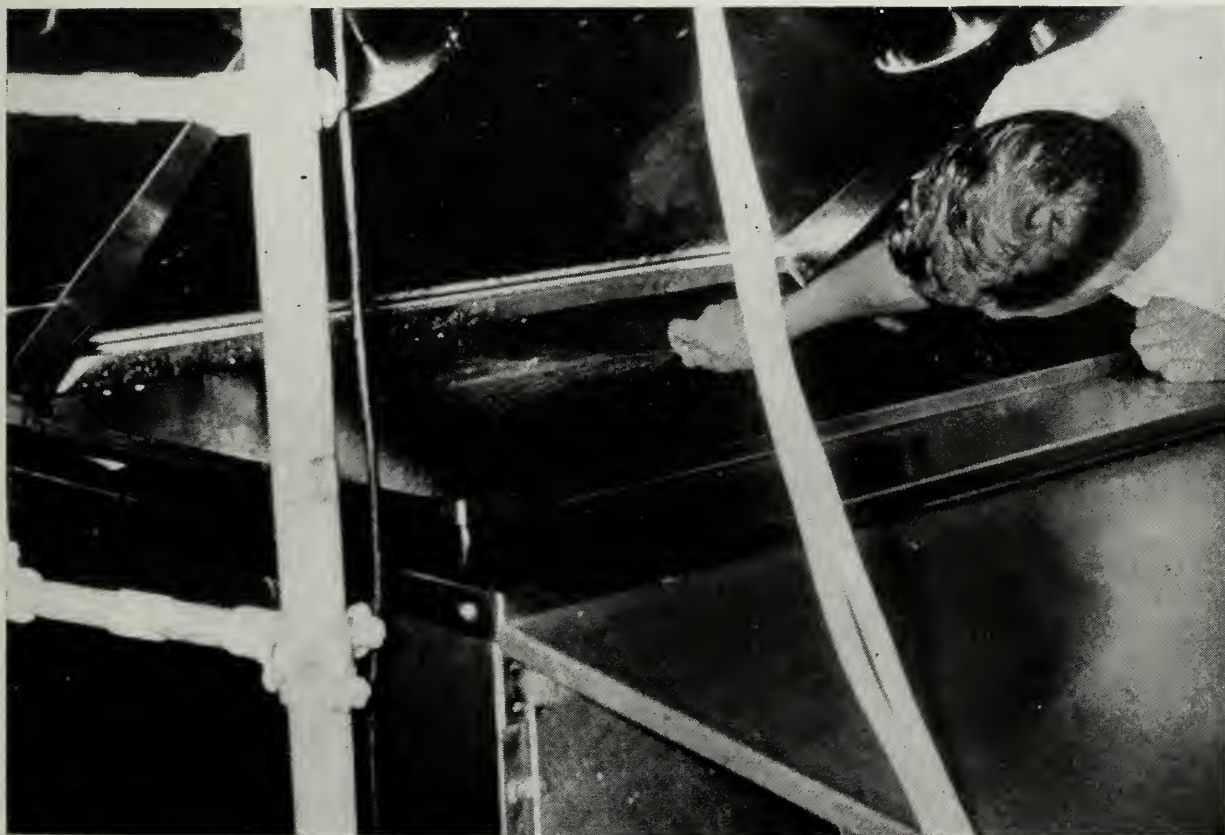
Where possible, the plumbing has been arranged along the barn wall, since this is the warm wall and consequently will minimize the freezing



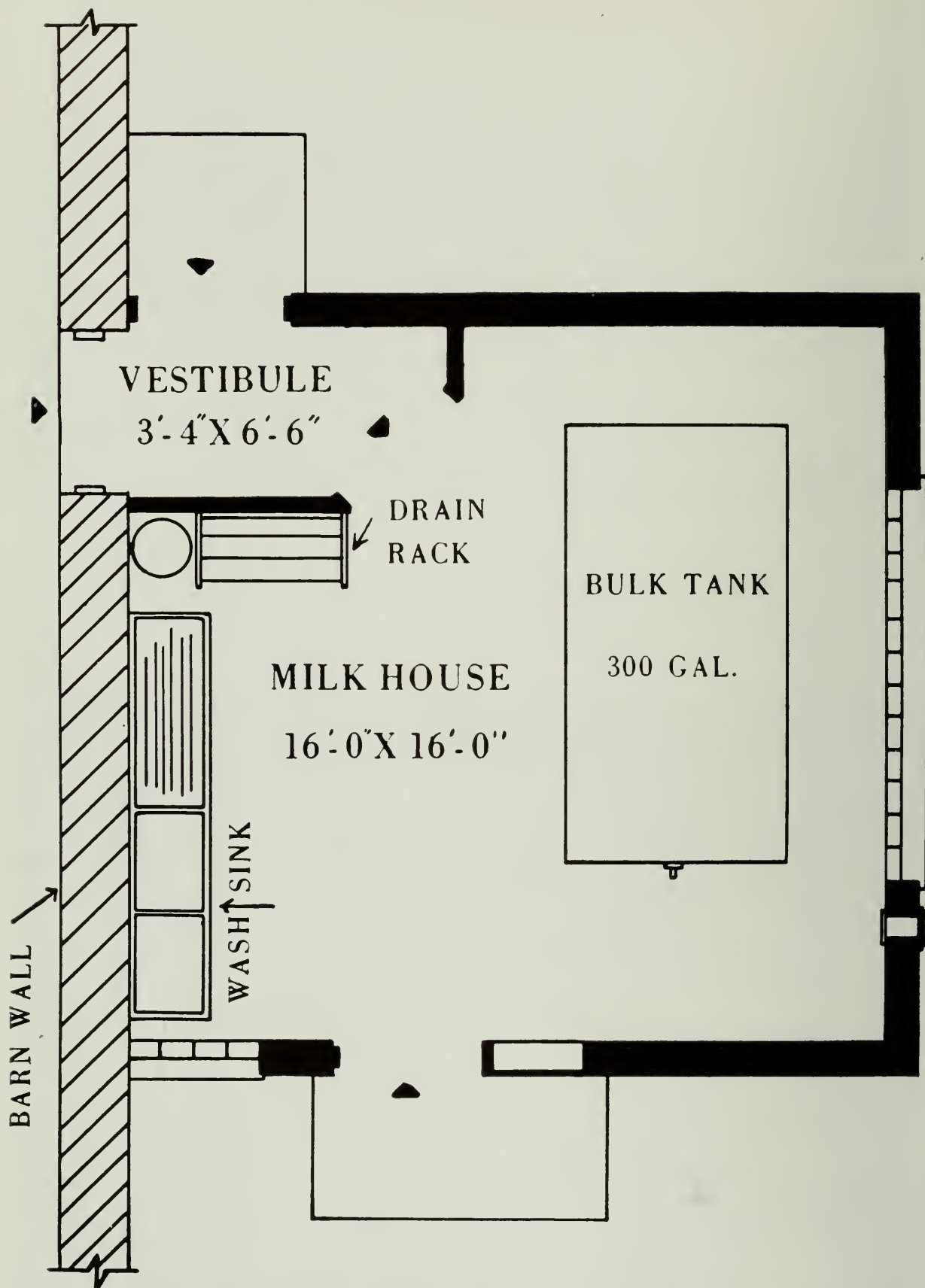
An interior view of the steel trap door. The electric outlets should be near the trap and near the milk house door for convenience.

problems. The sizes of the milk storage tanks are approximate for their capacity and, since the size and shape of tanks vary with the style and type, it is best to remember, when one is planning the layout, to allow a clearance of 24 inches on the side and back of the tank, and 24 to 36 inches on the outlet end of the tank. At least 24 inches, and preferably 48 inches, of clearance should be allowed on the filling side. This space will also be used to set down milking equipment prior to cleaning. Double wash tanks are preferred to single tanks to facilitate cleaning and rinsing. The drain rack is also used for storage of milking equipment.

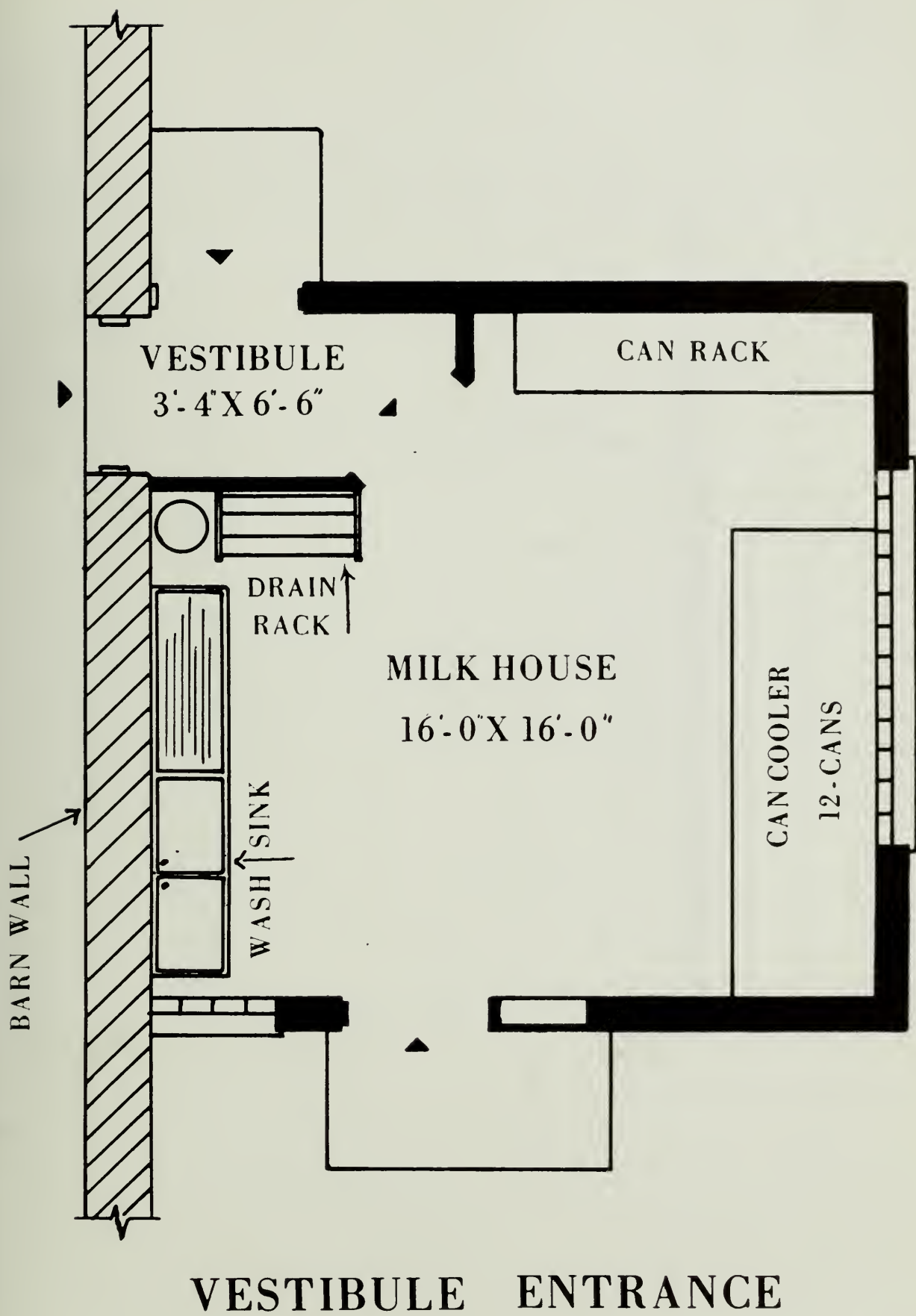
The following floor plans are suitable for both can coolers and bulk tanks in the arrangements shown. Four typical entrances are shown and can be located in the farmstead plan to satisfy individual requirements.

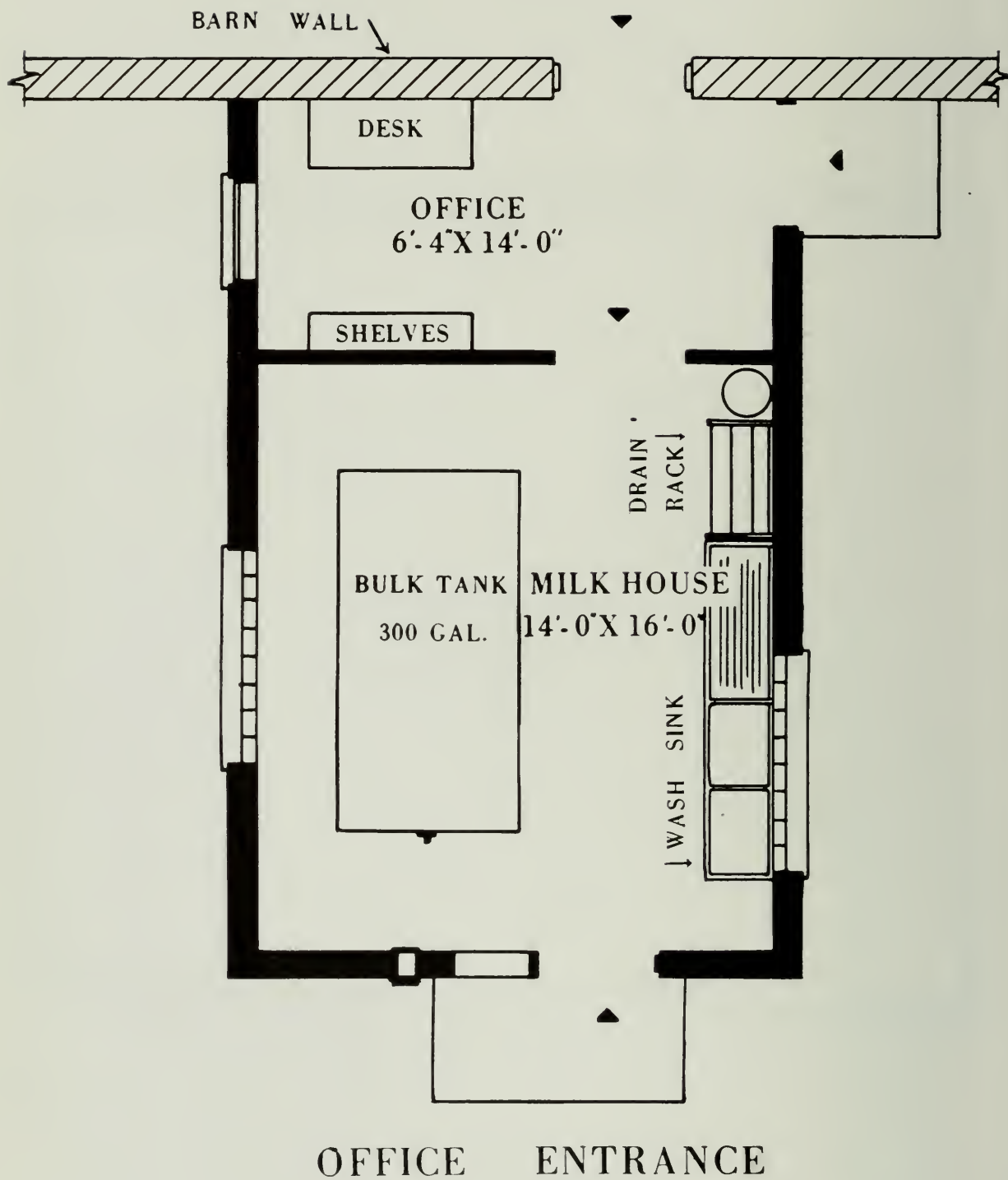


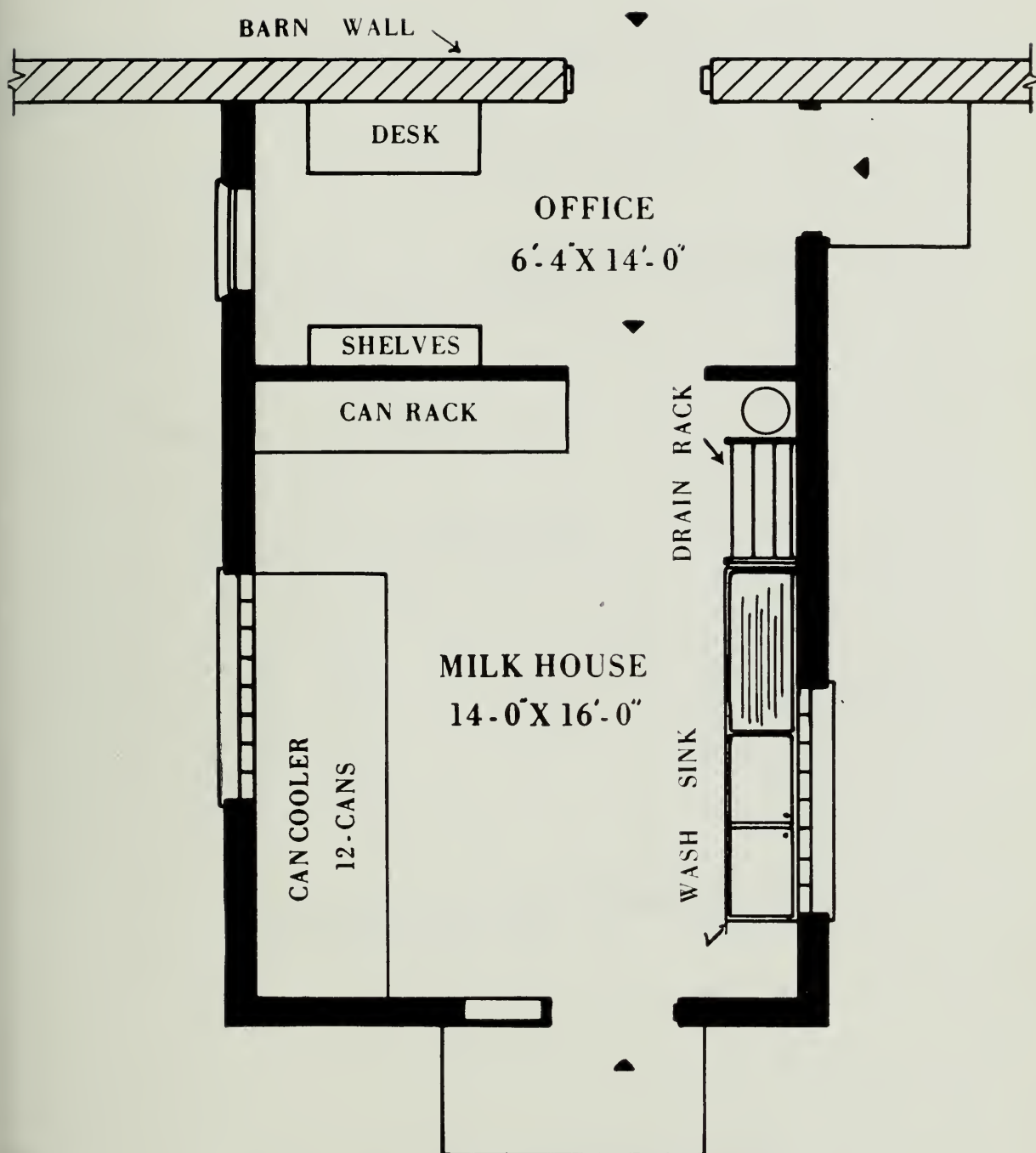
It is necessary to be able to reach all parts of the bulk cooler for proper cleaning methods.



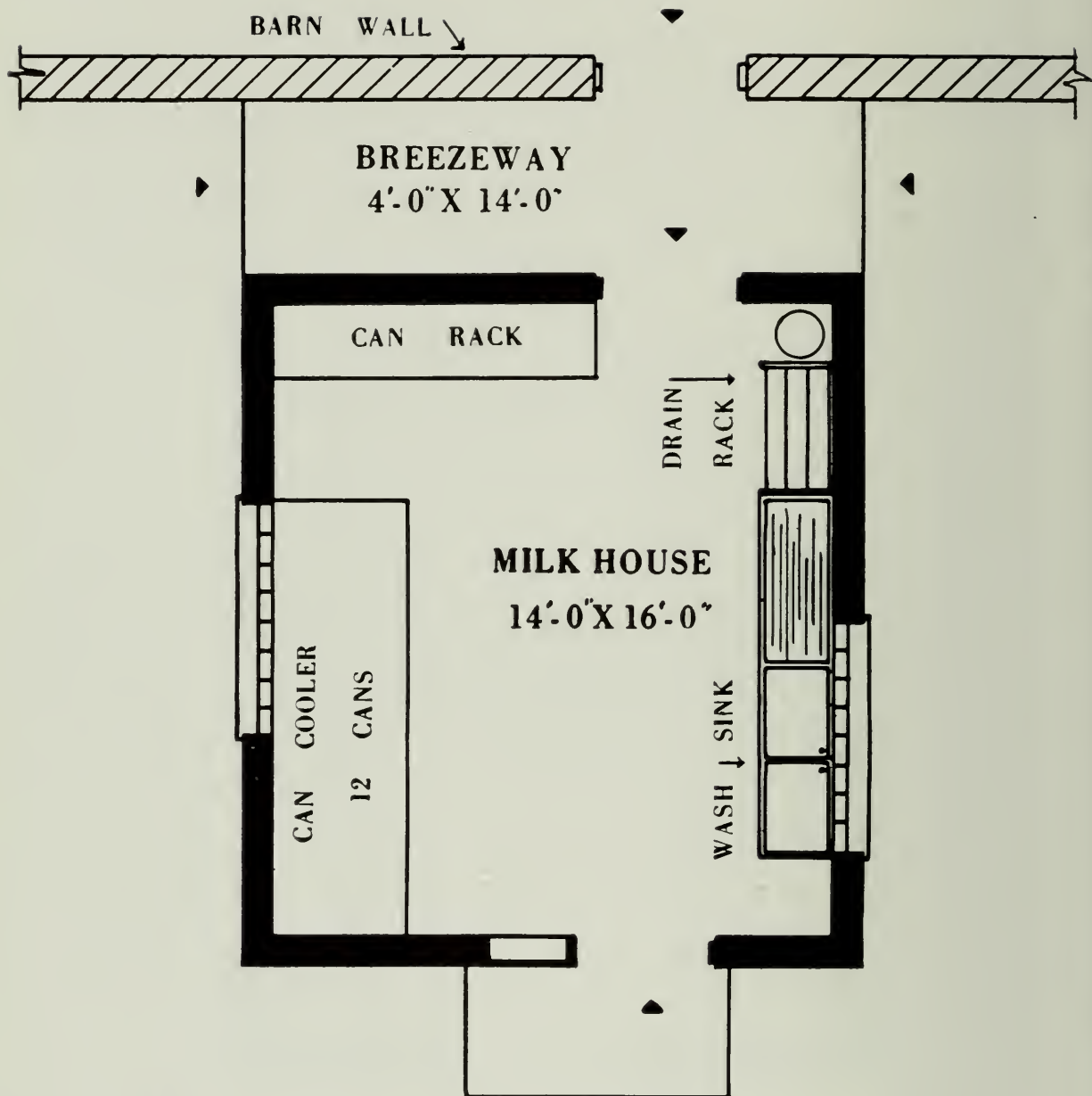
VESTIBULE ENTRANCE



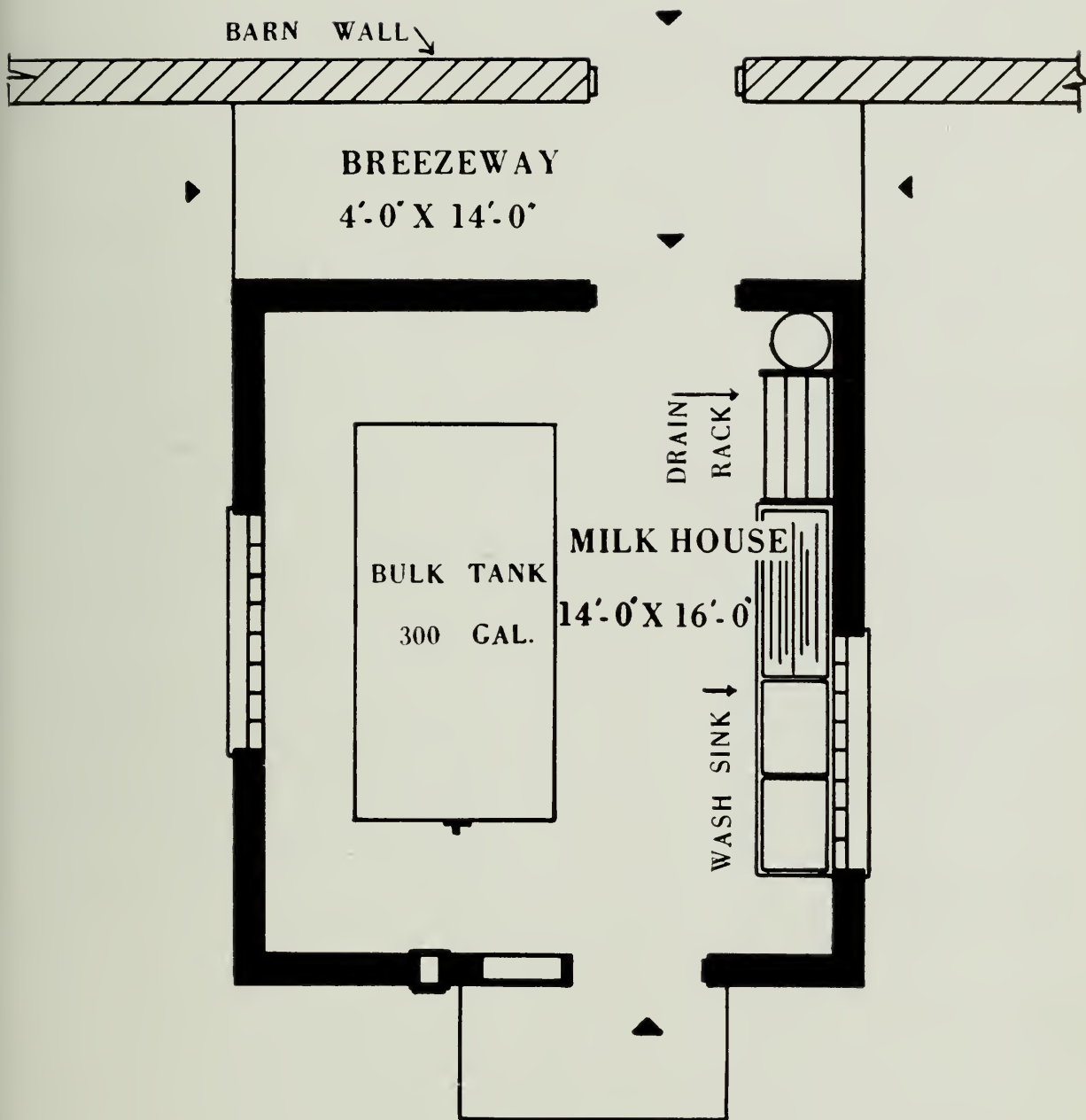




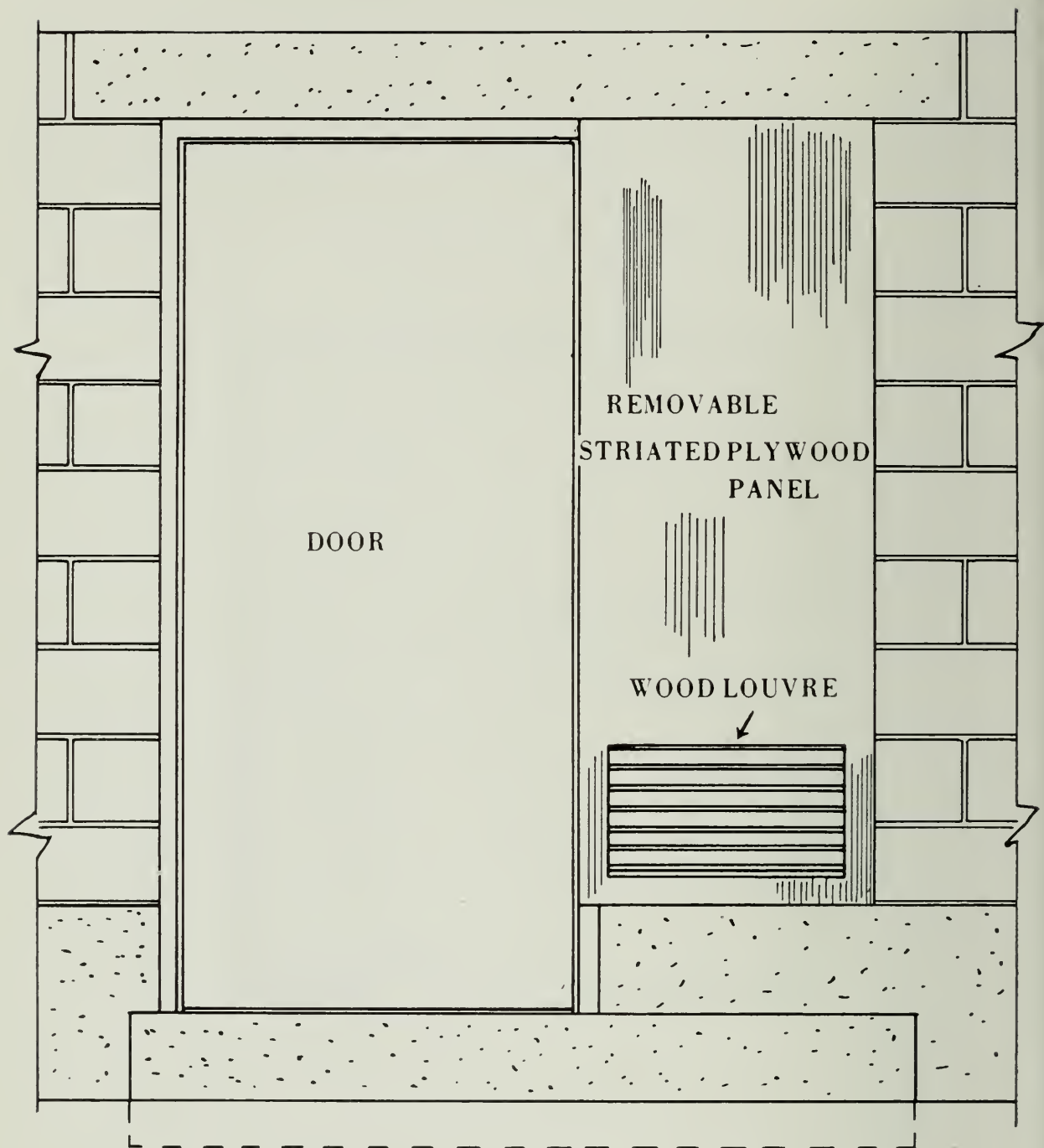
OFFICE ENTRANCE



BREEZEWAY ENTRANCE



BREEZEWAY ENTRANCE



REMOVABLE FRONT ENTRANCE

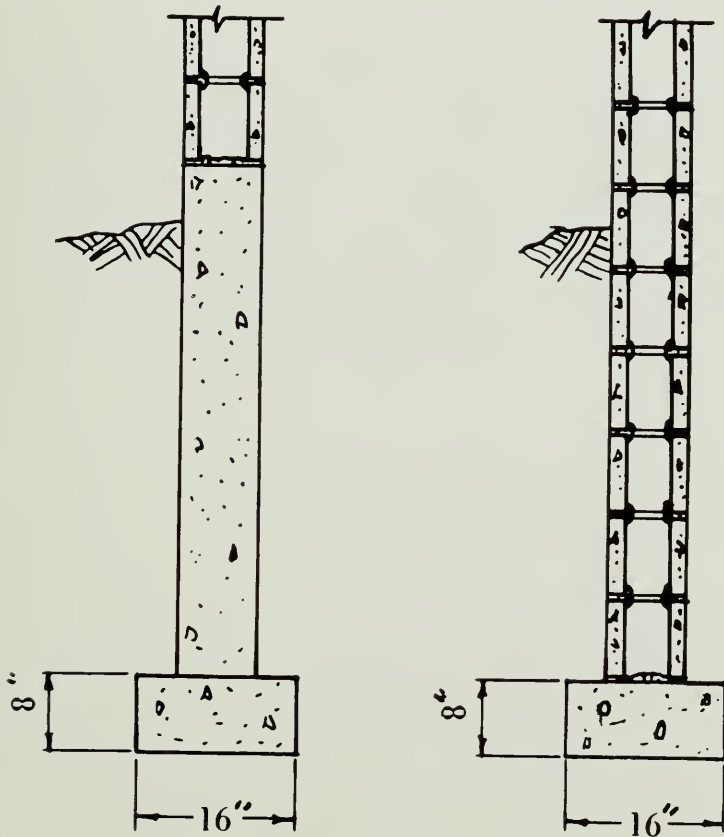
Methods of Construction

The most critical part of milk house construction is the footing and lower foundation wall because the total load of the building and its contents will be carried down through the footings and distributed evenly through the soil. If settling occurs in any part of the footing or if cracking takes place in the lower part of the foundation wall, the stability of the house will be impaired. This affects the sanitation aspects since bacteria thrive in openings in concrete and other structural materials. Settling of the building also affects the calibration of the bulk milk tank.

The concrete footing should extend to below frost line to avoid heaving or settling from frost action. The frost line varies in this province but is considered to be from 3 to 3½ feet below ground line in southern Ontario and 4 to 5 feet below ground line in northern parts of Ontario. It is standard practice to construct a footing with a thickness equal to the thickness of the foundation wall it supports and a width of footing equal to twice the thickness of the wall. For example, an 8-inch wall would, therefore, have a 16-inch-wide footing 8 inches thick.

Footings are constructed with poured concrete and, if the soil is firm, the concrete can be poured with the sides of the excavation being used as forms. If the soil tends to fall in, it will be necessary to use cribbing and form the concrete with lumber or plywood. Sometimes a simple footing poured in the bottom of the trench with concrete blocks for the foundation wall will be sufficient.

Many lightweight masonry units, such as concrete, cinder, and slag blocks, are available for milk house construction; if they are used, it is



TYPICAL FOOTINGS

necessary only to extend the poured concrete about 6 inches above the milk house floor level, providing the outside ground level remains below the top of the foundation wall.

In frame construction the height of the poured concrete must be 6 to 8 inches above the floor level since the floor will be washed down for cleaning purposes.

Floors

Concrete is the best material for construction of the milk house floor because it is strong, durable, and easy to wash down. If it is properly finished and cured, a smooth surface can be obtained to minimize dust and dirt collection.

Before a concrete floor is poured, the area should be excavated deep enough to allow about 6 inches of gravel to be tamped in place. This provides good underdrainage and also gives a good bonding surface for the concrete when it is poured to form the floor.

Since wash water and excess milk must be removed from the milk house, an underdrain is laid so that the top of the floor drain is about 1 inch below the floor surface. If a bulk tank is used for storage, the drain should be located close to the outlet of the tank. In all cases a bell-trap or other device should be installed to prevent drain odours from entering the milk house.

The concrete floor should slope $\frac{1}{4}$ inch to the foot toward the drain from all points of the floor. Greater slopes will be hazardous when the floor becomes wet.

Concrete

Since concrete is used in parts of all milk houses, it is important to properly mix, place, and cure it to ensure a quality structure. Only good sand, aggregate, cement, and water should be used in mixing if desired strengths are to be obtained. Sand and gravel should be free of silt and organic material, and the water should be pure and clean. If a good concrete mix is to be obtained, the aggregate should not be larger than $\frac{3}{4}$ inch in diameter. Pit run material can be used if caution is taken concerning the quality of the material, but it is desirable to draw sand and gravel from pits which have been known to produce material for good concrete.

The 1:2:3 mix is suitable for concrete work in milk houses and is easily proportioned into the mixer. This means that 1 sack of cement to 2 cubic feet of sand to 3 cubic feet of aggregate with just enough water to give a workable mix will be sufficient for footings, foundation walls, and floors.

Concrete takes a first "set" in 24 hours, a second set in 7 days, and a final set in 28 days. This gradual attainment of strength requires careful "curing" of the concrete during the first 7 days and is realized by keeping the surface of the concrete damp to assure the presence of moisture which is necessary in the strengthening process of the concrete.

No excessive loads should be applied to concrete until after the second set has taken place.

Reinforcing of the concrete floor is recommended since cracking may take place during shrinkage. This can be done by placing wire mesh or steel rods in the concrete $1\frac{1}{2}$ inches from the bottom of the floor.

Frame Wall

In wood frame construction, the concrete floor can be placed on top of the foundation and extended to the outside face of all the walls. Anchor bolts should be embedded in the concrete on about 5-foot centres around the edges of the floor slab and at all corners to tie the side walls to the floor. The usual frame construction is used with 2- by 4-inch studding spaced 16 or 24 inches on centre, depending on the material used for wall covering.

A wide variety of materials is available for exterior and interior application. The selection of the material will depend on the preference of the dairyman, availability of the material, and the cost. Most large size panels and metal sheets will allow 24-inch stud spacing, but where batt or blanket insulation is used between the studs and ceiling joists, it is better to space them at 16 inches on centre. Loose fill insulation can be used for any stud or joist spacing.

Wood siding, exterior plywood, cement asbestos board, galvanized and aluminum sheets, and insulating boards are some of the common materials used for exterior wall application. Smooth surface materials with a minimum of joints for easy cleaning, durability, and maintenance are essential characteristics of materials for interior application.

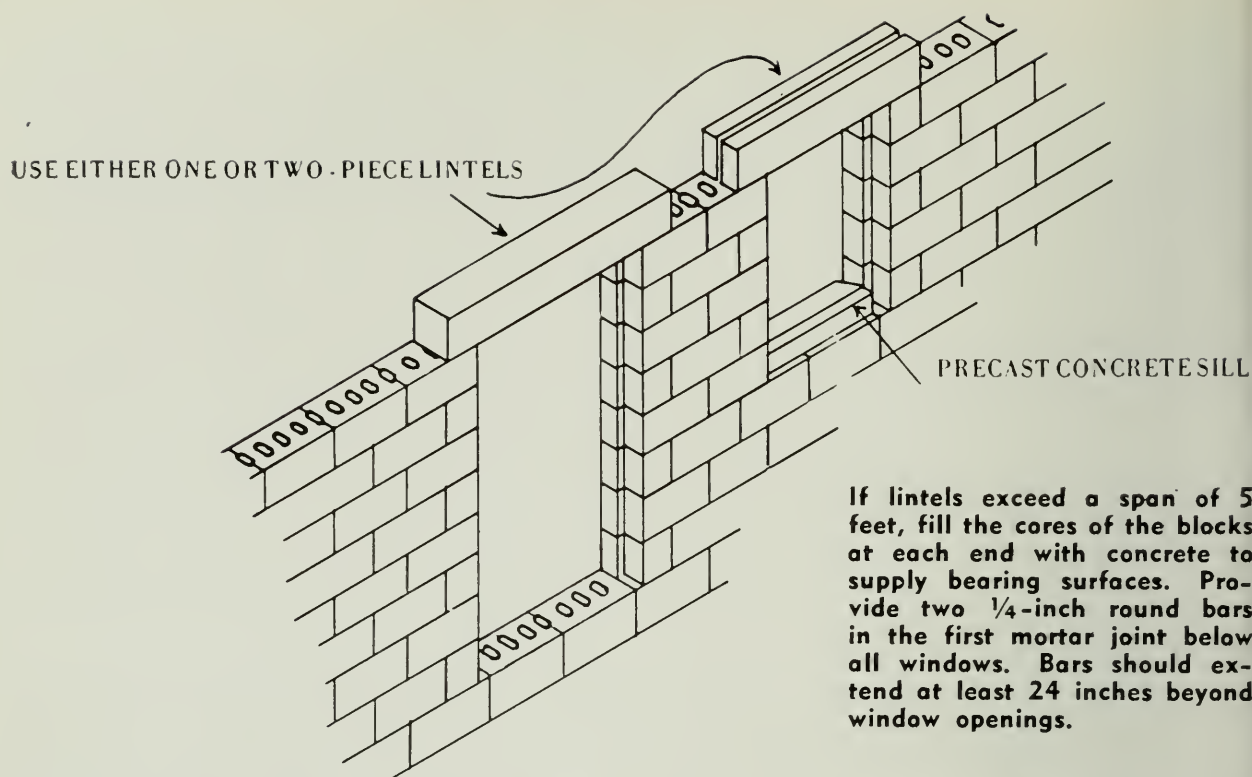
Masonry

There are many lightweight masonry units available for wall construction which provide a neat, strong, durable wall, if properly erected. Cinder, slag, and lightweight concrete blocks have a fair insulating value and in addition are fireproof and easy to clean. The insulating value of the blocks can be slightly increased if the hollow cores of the blocks are filled with a loose or granular type of insulation material. Usually an 8- by 8- by 16-inch block is used, the dimensions including mortar thickness. This facilitates calculation of number of blocks required.

If poured concrete, concrete blocks, brick, tile, or other solid masonry construction is used, it is necessary to add furring and insulation to prevent excessive temperatures and to limit condensation.

Openings over doors and windows are bridged by reinforced concrete beams called lintels. These can be purchased as precast beams or constructed at home. If cast on the farm, good forms, proper mixing, placing, and curing is again essential. Lintels are reinforced with steel bars placed 1½ inches from the lower side of the member.

Sills also may be precast or built at home. They are made to project about 1 inch beyond the face of the wall and are provided with a drip cap so that rain water running down the sill will fall free and not flow down the wall, streaking and staining it.



While blocks, lintels, and sills are easy to lay, careful workmanship is necessary to obtain the best results. Consistent plumbing and levelling the courses must be maintained. Both interior and exterior surfaces of insulating blocks should be waterproofed. Easily applied waterproofing compounds are available commercially.

A high-strength mortar, evenly applied on both vertical and horizontal joints, is necessary to obtain a good bond and bearing surface to prevent air and water leakage. Mortar properly applied enhances the appearance of the milk house.

Roof Designs

It is desirable to construct any buildings on the farmstead plan so they will blend architecturally with other buildings. If the styling of the new building is similar to that of the existing structure, it is often easier to blend the milk house into the existing dairy barn and a neater appearance is presented. This applies mainly to the roof design since in milk houses almost any roof type can be used. Probably a gable roof is more universally used because erection is simple, and fits into most of our existing farm buildings. However, hip, shed, flat, and gothic roofs are used with satisfaction.

In any design it is necessary to provide louvres or openings to carry off any condensation which is likely to occur in the building. In gable and gothic roof designs, openings in the ends at the attic level will carry off most of the moisture. In shed, hip, or flat roofs, it may be necessary to provide screened openings under the eaves.

The gable roof is easily constructed sometimes by using a simple truss with all the units being fabricated on the ground and then raised into position. This type of construction simplifies the installation of ceiling insulation and simplifies ventilating the attic space. The hip roof is a little more complicated to build and does not lend itself to simple truss construction. It is also more difficult to ventilate the attic properly. For either

type of roof, matched roof sheathing is required for asphalt or composition type roofing. A roof slope, or pitch, of 4 to 8 inches per foot will be satisfactory for most types of roofing, such as wood, asbestos, asphalt shingles, cement asbestos board, and various types of metal.

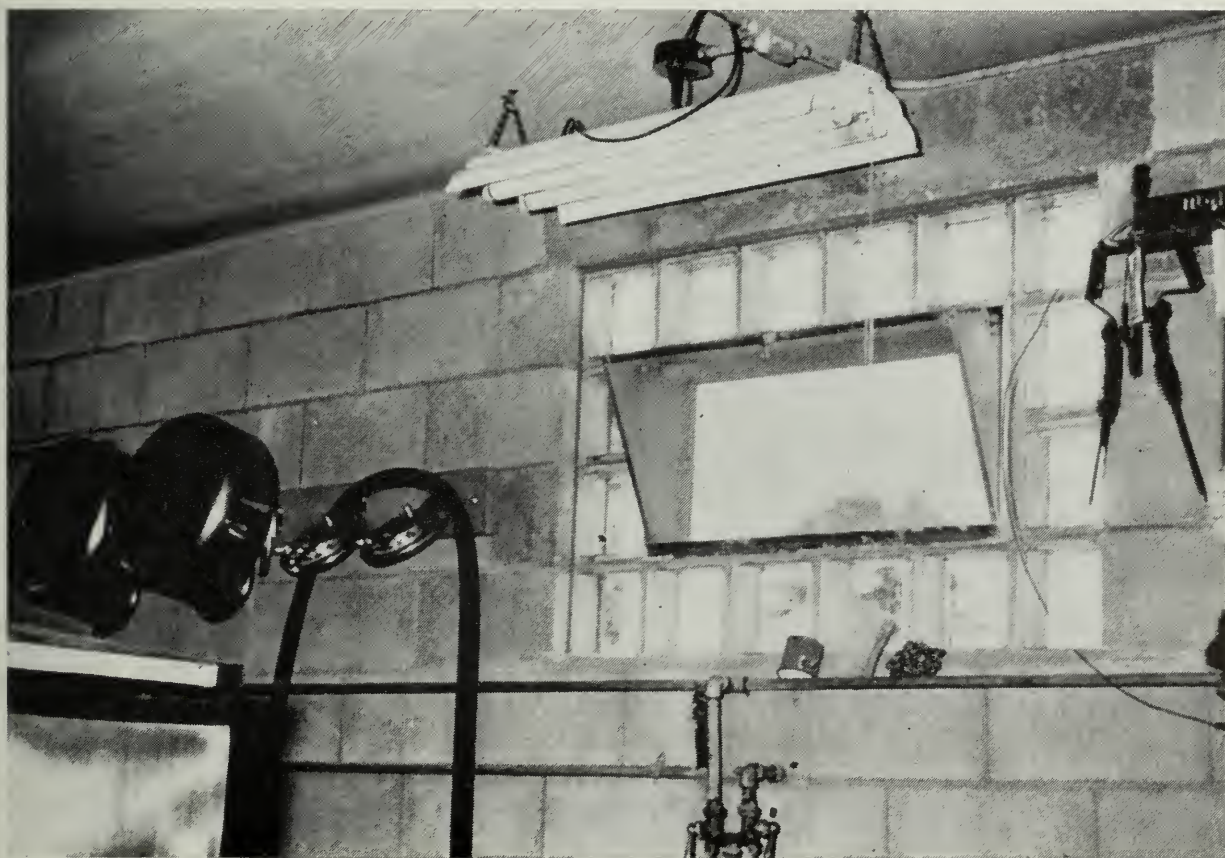
Rolled roofing can be applied to roofs having a pitch of 2 to 3 inches, and the double coverage type of rolled roofing may be used on roofs having a rise of as little as 1 inch per foot. Flat roofs are usually built up by using three or more layers of felt saturated with asphalt and covered with gravel. When this type of roof is used, experienced workmen with proper equipment should be employed who will guarantee a 20-year bond. In all cases, it is advisable to follow manufacturers' specifications.

Window Design

In most milk houses one or two windows will be satisfactory. The total glass area should equal not less than 10 per cent of the milk house floor area. Windows should be close to the ceiling, hinged at the bottom, and "swing-in" at the top. Storm sash and screens should be provided.

Glass blocks have been used frequently in the Province because of their strength, appearance, insulating qualities, and sanitary surfaces. The glass area in this case should be about 15 per cent of the floor area. Provision should be made for the installation of a small ventilating fan in one of the block openings since this type of window cannot be opened.

Insulated glass windows with $\frac{1}{4}$ -inch or $\frac{1}{2}$ -inch air space between two sheets of glass are available commercially and will fit standard windows. The advantage is that no storm sash is required and no frost occurs on the window.



Glass block windows with "tip-in" sash or central ventilating louvre are clean, attractive, and durable. Lights over the sink near the window satisfy maximum lighting.

Doors

Small milk houses attached to the side of the barn with a common platform and passage require only one outside door, but the door should be wide enough to permit passage of large bulk tanks and not less than 3 feet 6 inches in dimension.

It is sometimes desirable to instal a temporary frame wall at one side of the door. This two-foot section can serve as shelf space in the milk house and can be removed, if necessary, during exchange of milk tanks, with very little labour and no damage to the milk house.

Two doors may be desirable in large milk houses, one leading to the covered passage and barn and the other to the loading platform or approach. The latter should be about 5 feet wide.

Insulated plywood doors can be constructed by nailing plywood panels to either side of an insulated, reinforced wood frame. Doors should be hinged on the inside of the jamb to open inwards; this allows for the installation of a screen door to open in an outward direction.

A trap door should be built in the wall close to the outlet of the bulk tank and convenient to the loading area to permit entrance of the milk hose and the electric cord from the tank truck pump. The trap is a metal plate about 8 by 8 inches and hinged by heavy spring to ensure a positive seal when closed. The trap will reduce the number of flies gaining access to the milk house during pick-up time.

Suggestions for Wiring and Lighting

For convenience to the operator and for safety reasons it is necessary to pay close attention to the wiring and lighting installation in a milk house. Adherence to electrical code requirements is essential, and to ensure safe, sure methods a competent electrician should be employed. It is an advantage if the electrician knows the requirements of the existing farm wiring as he can then plan his work on a sound basis.

A study should be made of the floor plan to locate the best position of the lights and the controls for the lights, milk tanks, water heater, and heating units. It is convenient to have an outlet just inside the door to the milk house or next to the steel trap door so the truck operator will need only a short lead from the truck pump.

The whole system should be laid out to determine the number of circuits and voltage required for the circuits. Most milk coolers and water heaters operate on 220 volts.

Passageways, loading platforms, and an area just over the sinks should have artificial lighting; for maximum lighting efficiency a 150- or 200-watt frosted bulb placed in an enclosed globe or reflector mounted at the ceiling in the centre of the milk house is recommended.

Heating and Ventilation

Since the Province of Ontario has a variety of climatic conditions, it may be necessary to heat some milk houses, while others may need only temporary or supplemental heat. In any milk house, however, even if normally no additional heat is required, it is expedient to provide some heat in unusually cold weather to give the operator comfortable working conditions and to prevent freezing of the pipes. Unit heaters, space heaters, heat lamps, and hot water radiators may all be used with satisfaction.

The milk cooler condenser provides considerable heat from the cooling milk, and this heat can be dissipated through the milk house if the condenser is exposed. In the summer weather a duct leading to the outside should be constructed to carry away excess heat.

It is desirable to carry off odours and excess moisture from the milk house but in ventilating, for this reason, considerable heat will be withdrawn, which increases the heating problem. Therefore, careful observation plus experience will enable the operator to balance the ventilation with the heating requirements.

To heat and ventilate a milk house efficiently it is recommended that insulation in the walls and ceiling be used. In some cases insulating blocks are satisfactory but in most areas commercial insulation is advised.

Note:

Since both can cooling and bulk cooling will exist in the Province of Ontario for some time to come, plans will be made available for each type of cooling. It is emphasized that the change will be from can cooling to bulk cooling and, since the can equipment will, in most cases, occupy more space than the bulk tank and accessories, no difficulties should be encountered in the changeover.



FARM HOME SURROUNDINGS

CA20NAF6
B521

ONTARIO AGRICULTURAL COLLEGE, GUELPH, CANADA



ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

Minister
Honourable W. A. Goodfellow

Deputy Minister
Dr. C. D. Graham



TABLE OF CONTENTS

	Page
Planning to Suit Surroundings With Costs as the Overall Factor	5
Planning the Landscape Development	5
Location and Soil	6
Plants to Use	7
Sources of Plant Supplies	9
Maintenance Cost	9
The Lawn Area	10
Hedges	13
Annuals	15
List of Flowering Shrubs Suitable for Farm Homes	16
List of Annual Flowers	19
A List of Suitable Deciduous Trees for Farm Homes	22
Paper Graph	25
Additional Publications	26

FARM HOME SURROUNDINGS

by

J. A. WEALL

Department of Horticulture

Ontario Agricultural College

Guelph, Ontario

Our homes and the grounds that surround them have a warm place in our hearts, our memories, and our daily lives.

Farm homes, particularly, offer the chance for more spacious outside development than do city dwellings, and this extra space for garden features of lawn, trees and play areas deserves special attention. Then, too, the fact that our farm homes occur only occasionally along our highways makes them command much more attention as landscape features than do the clustered homes of our cities and towns. This means that the farm dweller has an obligation and a challenge to show that, with the help of natural beauty, he can display to the passer-by a home that will compel admiration and attract envious attention.

To promote improvement in farm home surroundings and thus to create beauty, increase property values, and conserve natural resources is the purpose of this bulletin.

It is to be hoped that once the home owner has started the landscape improvements to the property, the annual clean-up and paint-up will become an organized affair, which spreading through the countryside would make our province that much more beautiful. It is hoped, also, that the text, illustrations, and planting lists presented here will prove to be of real benefit.

PLANNING TO SUIT SURROUNDINGS WITH COST AS THE OVERALL FACTOR

Perhaps one of the more important items in planning for improvement of the farm home grounds is the question of cost. No matter how clearly the explanation and presentation of a plan may have been given to the farmer, his thoughts throughout the discussion will be centred on the probable cost of the work.

"How much will all this cost?" he will ask when the plan is presented, and this same question should be the cautionary control-lever when the plan is being prepared.

Several ways in which costs may be kept within reasonable bounds are as follows:

1. Using, as far as possible, native material grown on site.
2. Careful planning for easy maintenance.
3. Grazing some of the grass areas by animals.
4. Using forest trees in conservation work.
5. Spacing trees and shrubs farther apart than is usually recommended.

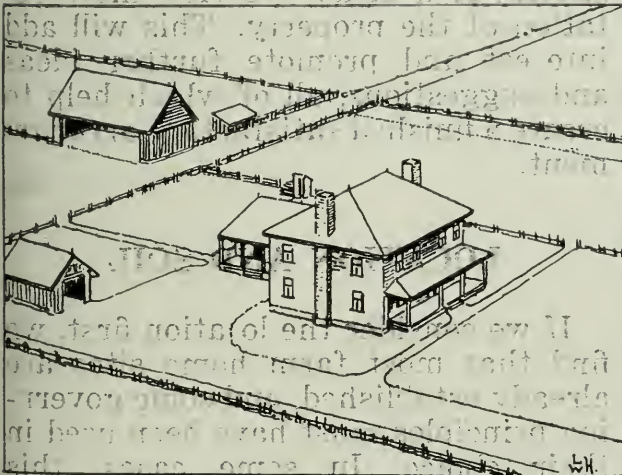
The careful use of some or all of the foregoing suggestions will enable one to keep to a minimum the initial cost and, which is equally important, the maintenance cost.

PLANNING THE LANDSCAPE DEVELOPMENT

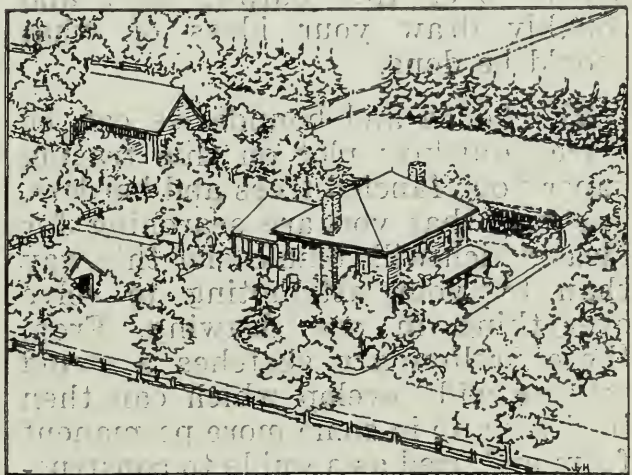
It is a matter of good organization to plan any new scheme, alteration, or arrangement of material. This applies to gardening just as much as to building, and a map or plan that shows the site and boundaries of the estate, the buildings, any existing trees, roads, compass bearing, and scale of drawing is essential before any ideas are developed for planting and improving the farm home grounds.

This plan need not be an expensive-ly drawn-up survey. Anyone who has taken the trouble to reproduce on paper an approximate scale drawing of an outline of a house plan will appreciate the fact that an intimate knowledge of the object is gained that cannot be obtained by any other means, and this surely justifies some effort in the planning direction.

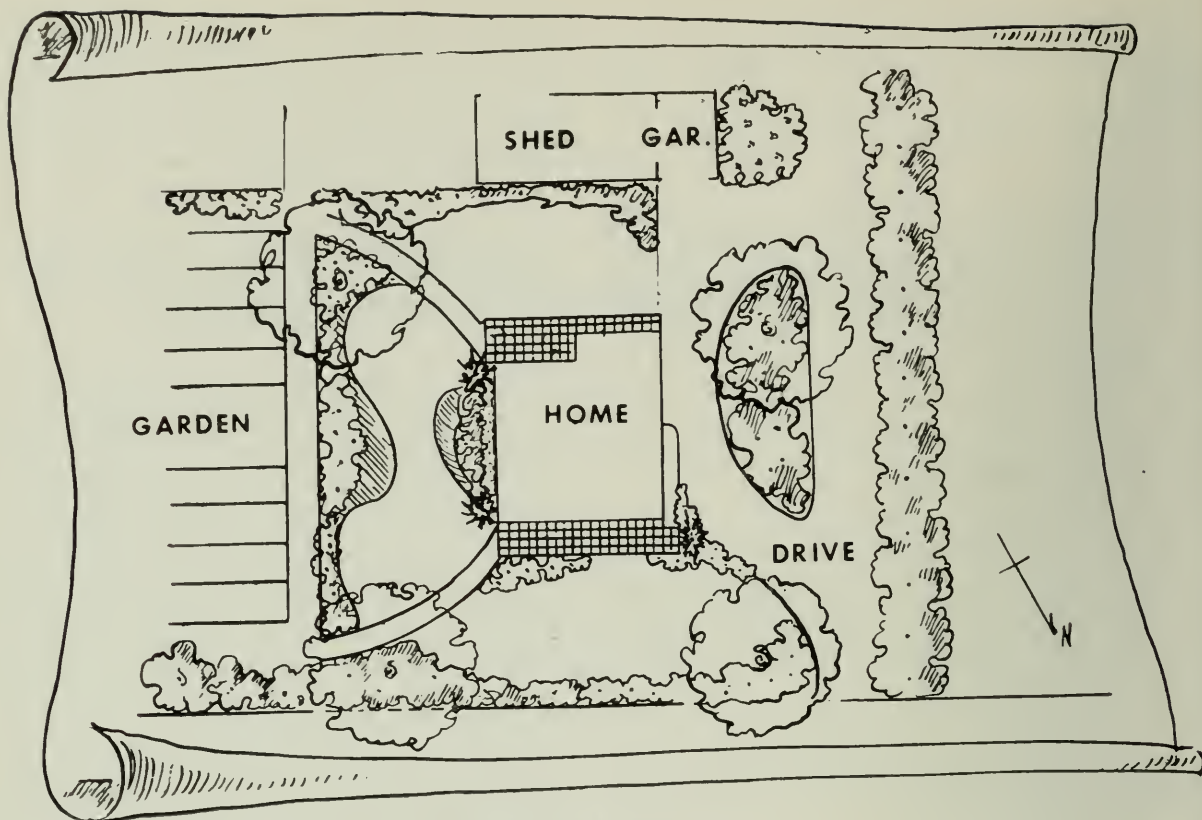
As your plan progresses, you realize such matters as the requisite needs of a suitable driveway width for your car, proportion of space for various areas of the garden, and the



Before.



After.



Farmstead Planning.

importance of direction of sunshine and wind, grades, and the many problems pertaining to construction. You can solve these problems best through this method of paper planning.

There will be several schemes in mind, no doubt. A simple way to arrange and assess your ideas is first to draw the outline of house and boundaries on a large sheet of paper or cardboard and mark in ink all existing features. Now place, in turn, sheets of transparent paper (detail paper) over this outline plan and roughly draw your ideas of what should be done.

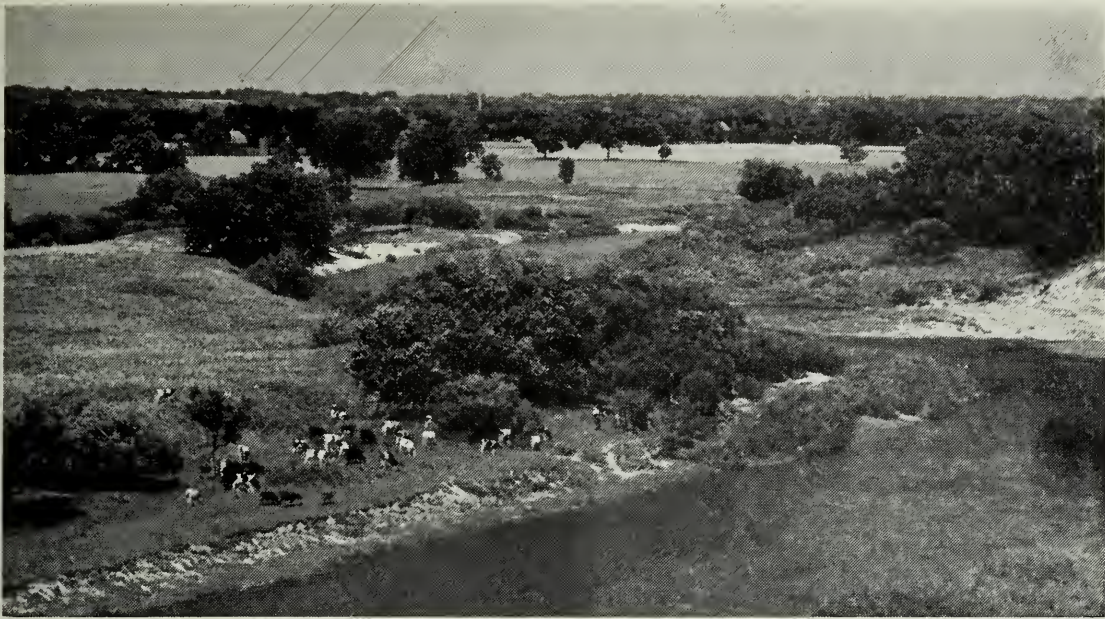
The house and boundaries can be traced quickly; plot on this tracing paper your fancied trees and borders, knowing that you are searching for ideas which will come easier this way than by your attempting to solve everything in one drawing. From these preliminary sketches a sound scheme will develop which can then be drawn up in some more permanent form and used as a guide to construction and planting.

This plan (for such it has now become) may be still further enlarged for detailed drawings of particular areas such as shrub borders or perennial beds. The plan will serve as a basis for argument, a record of achievement, a means whereby the cost of the work can be estimated, and a chart for the construction worker or planter to follow.

If you have the ability to draw, then this plan can be still further advanced to an elevation drawing, a sketch, or a bird's-eye view interpretation of the property. This will add interest and promote further ideas and suggestions, all of which help to create a finished satisfactory arrangement.

LOCATION AND SOIL

If we consider the location first, we find that most farm home sites are already established, and some governing principles must have been used in their choice. In some cases, this choice was made because of proxim-



Scenes of such pastoral beauty provide the setting for thousands of Ontario farm homes.

ity to road or rail or because of drainage and grade of ground; in other cases, sites have been selected largely because of natural setting, that is, for beauty.

Whatever the reason, usually some sound common sense has been employed. From the point of view of appreciation of beauty, if a new site can be chosen that already has a background of trees for shelter, a gradual slope in front, and available water, then the stage is set for developing beautiful home grounds.

Now for the soil situation. Without good soil there can be no good garden, no fine trees, no excellent pasture. It is very important, therefore, if the choice is yours, to examine well the depth and texture of soil. Soil can be improved and built up by fertilizer and crops, but only at great expense of time and money.

But if you have no choice and yet desire to improve your home surroundings by planting trees, then it is better to plant a few trees in well-prepared holes, even at the cost of slowing up the whole program, than to plant lavishly in poor soil with resultant heavy losses and disappointment.

Good foundations are just as important in gardens as in houses, and soil is the basic factor in successful plant growing. For ideal purposes, the soil should be good loam, well drained, 12 to 14 inches deep, and well supplied with organic matter.

Success in landscaping is not measured so much by quantity and cost as by quality and common sense.

PLANTS TO USE

Use of Established Material

Any healthy plants on the grounds in the form of trees, hedges, and lawns should be retained when re-designing the property.

Trees that are established give a sense of age and majesty that takes years to achieve. Therefore, much thought and judgement should be given before deciding to cut down any established trees. On the other hand, this hesitancy to destroy, through sentimental thought, often impedes improvement.

In the case of rural surroundings particularly, the use of existing material need not be restricted to what

is actually in the home grounds. Distant views and prominent landscape features should be preserved and worked into the scheme by means of eye-leading vistas or breaks in boundary plantings.

Available Natural Plantings

Much beauty can be obtained by grouping cedars to hide buildings, placing well-formed specimens of maple, basswood, or elm in open spaces, or lining a streamside with red-stemmed dogwood, alder, or witch hazel bushes. Most of this material is native in Ontario and can be safely transplanted.

Better success in transplanting is encouraged if the roots are pruned one season before the plants are moved. This can be done by trenching around the tree at a safe distance from the stem, say 3 feet away, and cutting all roots with a sharp spade. The trench is then filled in again and left for one complete growing season, at the end of which time fresh roots will have formed to make a compact and vigorous root system.

Care should also be given to the preparation of the site to which these plants are to be moved. Before making a deep and wide excavation, choose a soil site that is suitable for whatever is to be planted, as, for example, leaf mould and moist earth for cedar, woodland soil and sand for silver birch.

Special Farm Planting Materials

In the long list of available flowering plants, there are many that do not require much attention. On a farmstead this should be taken into consideration, for little time will be available for staking, spraying, or subsequent care.

Peonies, iris, Oriental poppies, sweet williams, daylilies, and holly-

hocks are all easily maintained, whereas delphiniums, phlox, and most of the later blooming plants require attention if they are to be successfully grown.

Such well-known shrubs as honeysuckle and lilac seem most appropriate to farm homes, and the Harrison's Yellow rose is also associated with farmsteads. Beautybush, spirea, and mockorange can be added to the list because these shrubs are hardy and require little pruning if planted in their correct position the first time.

A word about the barberry may be in order here. Because the common barberry is the host for stem rust on grain, there have been demands for its complete eradication, and the very name barberry is immediate cause for suspicion.

There is no doubt of the guilt of the common barberry. It can be easily identified: (a) it grows 6 to 12 feet high; (b) the leaves are green or purple with saw-toothed edges; (c) its spines are usually in groups of three (d) the flowers and berries are borne in long drooping clusters; and (e) the rust spores appear on the under sides of the leaves. These spores when ripe may be blown to great distances to infect wheat.

On this subject, see Circular No. 49, "Rid Ontario of the Common Barberry and the European Buckthorn", revised June, 1950, released by the Ontario Department of Agriculture.

However, the Japanese Barberries, both green and red, are quite harmless to grain and can and should be grown for ornamental purposes in Ontario. They have never been known to harbour rust spores. The Japanese Barberry (a) is a low spreading shrub from 2 to 5 feet high; (b) has leaves which are small with smooth edges; (c) has spines which are usually single; and (r) has flowers and berries which are borne singly or in two's, three's, or four's.

SOURCES OF PLANT SUPPLIES

Trees for Windbreaks, Reforestation, Shelter Belts

Small trees suitable for these requirements and especially grown in nurseries at Government Forestry Stations are available to farm owners at nominal cost.

Farmers wishing to receive trees for planting should submit their requests on form R23, "Application for Forest Trees". These forms are available from Reforestation Offices or by writing directly to The Department of Lands and Forests, Parliament Buildings, Toronto 5.

Trees and Shrubs for Decorative Purposes

There are many well-established nurseries throughout Ontario where good nursery stock is grown. These nurseries issue well-illustrated catalogues and provide good transportation services which ensure prompt delivery of stock.

In addition, there have been for many years a well-organized mail-order business and a travelling sales organization in which qualified men visit outlying districts and spend considerable time advising customers and discussing with, and showing to, them by means of coloured pictures the most suitable planting material for different positions.

Then, too, in more recent years, Garden Sales Yards have enabled purchasers to drive in to well-stocked yards where nursery stock is displayed, there select their needs, and take their order away with them.

Perennials, Annuals, Bulbs, Seeds

Many flowering plants can be raised from seed, and many farmers with an interest in garden material have developed a sideline raising perennials

and bedding plants, and have established road-side stands in season.

In general, the plants your garden needs are within the range of everyone through modern methods of sales and distribution.

MAINTENANCE COST



Reference has already been made to the matter of maintenance cost, but this subject needs further enlargement. Some expense will probably be entailed in replacement material, but the greatest expense will be for labour.



Here spacious grounds and well-sited buildings combine to provide an enviable planting opportunity.

Maintenance demands such work as grass cutting, border cultivation, spraying or dusting for the control of insects and disease, staking and

tying, pruning, mulching, weeding, watering, and many other tasks necessary for the good appearance of a garden.



A formal entry layout that will improve as the shrubbery increases in size.

One should budget for the equipment, mowers, garden tools and pest control equipment and materials when considering the annual cost of the grounds. Some of this equipment can be accumulated gradually through the years and, as in farming, the use of good equipment results in ease of accomplishment.

Well-kept grounds give an air of refinement to the home and a favourable impression to all visitors. They are something that can be attained by family co-operation in which all can share the pride.

THE LAWN AREA

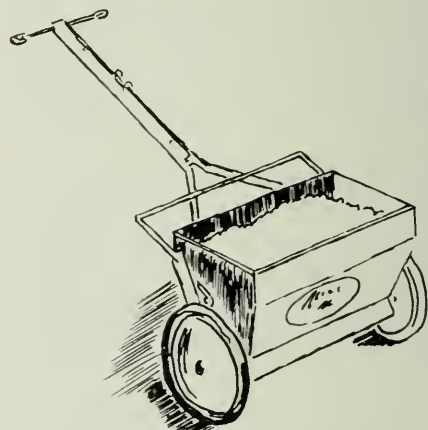
Generally speaking, most farm homes are found in natural setting, with adjoining woodland, arable land, and grassland.

To some extent the city homes also, in their desire to copy nature, have these three areas in their landscape arrangement, and the lawns usually surround the house and form the recreational area for the family. The lawn serves two purposes: (a) to beautify the home surroundings, and (b) to provide a playing area for young people; for these reasons, the lawn should be formed into large open spaces and made to stand much wear.

It is desirable, then, to set out the points in the making of a good lawn with a few notes on each operation. The lawn should be sown in late August or early September, which is the natural season for lawn-seed germination and offers correct temperatures for grass growing. There is less weed competition then and usually it is not quite such a busy period as spring for labour conditions.

Location of Lawns

Study the landscape diagram and determine the size and shape of the front, side, and rear lawn areas. Keep the front lawn broad and open in the centre, framed with trees and borders, and not broken up with patchy flower beds or specimen shrubs.



**Fertilizer
Spreader**

Keep the walks and drives near the lawn edge as much as possible; this leaves an open space of lawn for easy maintenance and good appearance.



An open lawn area adds depth to the view.

Draining and Grading

Leave natural curves and slopes where practicable but grade the land to obtain (a) good drainage away from the building, and (b) a smooth surface for easy mowing. Grading should be done when the soil is dry, and the land adjoining the building should be somewhat higher than other parts of the lawn to assure good run-off after heavy rains.

All steep slopes and terraces should be rounded off and have easy lines instead of sharp angles. Where it is necessary to grade deeply or to make fills, the topsoil should be removed and piled so that it can be spread over the exposed subsoil when grading is finished.

Lay tile, if necessary, when an outlet is available. Use 4-inch tile in

trenches about 2 feet deep and 20 feet apart, with a fall of about 3 inches to 50 feet.

Preparation of Seed Bed

Plough or spade the ground 4 to 5 inches deep well in advance of seeding time, occasionally harrowing and raking to destroy any weeds.

If the soil is poor or sandy, or where topsoil has been removed, apply a 4-inch layer of soil high in humus and free from weed seeds. If time permits, it may be advisable to grow and turn under soil-improvement crops, such as legumes or winter rye, during the winter and summer preceding sowing of the lawn grass, with the necessary fertilizer added to ensure rank growth. These crops should be turned under well in

advance of seeding so that they will be converted to decomposed organic matter. The seed bed should be well compacted with 1 inch of fine tilth left on top.

Secure Suitable Seed

Estimate the amount of seed required at the rate of 4 pounds per 1000 square feet, then purchase from a reliable source the best quality seed obtainable for your particular character of soil.

Sowing the Seed

Morning is the best time to sow seed; there is usually less wind, and there is all the rest of the day in which to complete the job. Use plenty of seed. Thick seeding lessens weed competition and produces a quick stand of grass. Small areas are usually seeded by hand. The seed should be sown evenly, and it is wise to divide the amount of seed in half and sow half in one direction and then sow the other half at right angles to it. The cyclone type of seeder speeds up the operation but is inclined to broadcast the seed over flower beds, sidewalks, etc. The low fertilizer spreader on wheels with adjustable slide openings is ideal for sowing lawns because an even distribution of seed is made close to the ground and none is spread over into adjoining borders.

After seeding, a light raking will cover the seed with soil to a depth of 1/8 to 1/4 inch; this is followed by a light rolling to compact and moisten the soil.

Protection of Newly Seeded Area

It may be necessary to protect a newly sown lawn against damage by animals and young children. An effective way is to place branches,

especially thorn branches, around the edge or at strategic points. Steep slopes should be sodded, but they can be sown and protected from washout by strips of cotton netting which can be left on to rot when the grass grows through.

Germination

After nine days, if the soil has been kept moist, the young grass should have appeared, and it will be necessary to roll again with a light roller to close up the cracks in the earth and bring up moisture. This is one of the most important items in the lawn-making operation.

Mowing for the First Time

New grass should be cut when it is about 2½ inches high; it is important that a sharp-bladed mower be used, for otherwise the grass will have a damaged appearance. When cutting a new lawn, see that the soil is dry enough to support machine and operator without leaving depressions in the surface.

The first cutting of grass rots quickly and should be left on the ground as a mulch. It is usually necessary to cut a fall-seeded lawn before winter, but if the growth is not vigorous the grass is better left uncut for the winter.

Maintenance of Lawns

To obtain a good appearance of a lawn through the season, it is necessary to put some effort and expense into the maintenance or care of it.

For further information on lawns, see Bulletin No. 448, "Lawns", Revised May, 1955, released by the Ontario Department of Agriculture.



Older style homes can be blended with the countryside
by thoughtful planting.

HEDGES

Long lines of deciduous or evergreen material are often planted to form divisions between properties and for use as boundary screens and windbreaks. They can be used as divisions between various parts of the garden scheme, such as between lawn areas and kitchen garden or between the perennial border and the recreation area.

A driveway is enhanced if planted either one side or both sides with trimmed hedges. Hedges are sometimes planted across front lawns to screen roads, give privacy, and shut out noise.

Types of Hedges

The most common forms of hedges are:

1. Sheared hedges, usually from 1 to 10 feet high.
2. Unsheared hedges, in which the plants are set in rows but are allowed to grow freely, following their natural habits.
3. Edgings. These are usually sheared, as in No. 1, but are much smaller in their dimensions, usually 1 foot high or less.

Sheared Hedges

For sheared hedges, it is wise to use material that will stand clipping and plants that are valued more for foliage and habit than for bloom.

Such deciduous material is available in the various privets, barberry, alpine currant, Lemoine's mock-orange, caragana, Japanese quince, and ninebark.

Japanese yew, white cedar, red cedar, and spruce are the favourite evergreens used.

Unsheared Hedges

For unsheared hedges, spirea, bridal wreath, honeysuckle, lilac, Father Hugo's rose, forsythia, and rose of Sharon are suggested.

For evergreen hedges, hemlocks are outstanding in their graceful informality. Mugho pine can be used effectively.

Edgings

Edging material is furnished by spirea Anthony Waterer, dwarf viburnum, lavender, or box barberry. Evergreen edgings can be planted in boxwood or globe cedar.

Planting Hedges

The best method is to dig a trench 18 inches deep, mix some well-rotted manure in the bottom layer of soil, and place the plants, spaced according to their requirements, in a straight, single row. If the material is of bushy type, like honeysuckle or lilac, the plants should be spaced 4 or 5 feet apart, but for wall-like effects of privet, 2 feet apart or even 18 inches apart seems to be sufficient. Ultimate height and width should govern the spacing.

All hedges should be cut back severely at the time of planting to encourage basal growth. If this is not done, the hedge may thicken at the top and gradually get sparse and open near its roots.

When to Trim Hedges

Most persons prune their informal hedges during the dormant season in late winter or early spring; it is thus one of the first operations when the weather becomes pleasant enough for one to commence gardening. In many cases, this is the only pruning for an informal hedge during the year. Rarely, however, is this one cutting enough to keep a formal hedge in perfect condition. This subject of pruning is presented in Bulletin 483, "Pruning Ornamental Trees, Shrubs, and Vines", released by the Ontario Department of Agriculture.

For a perfect formal hedge, trimming at least twice a year is practiced: first, in late spring or early summer and second, about a month later. The first trimming for shape and size does much to avoid a ragged appearance. The second pruning eliminates bulges at the top and brush heads which may result from the earlier pruning. Occasional trimmings

may also be advisable for formal hedges to maintain their smart appearance.

For arborvitae or cedar hedges, the best time to cut is early spring, just before growth begins, when all cuts are soon covered by the new growth. Yews may be lightly cut again in the summer. For pine or spruce hedges, which are mostly for large places, early spring is the time to cut for best all-year effect.

The pruning of hedges should be done annually, and if they cannot be pruned at one season, it is better to prune at another than to neglect them. If possible, hedges should be trimmed during a period of dull weather to avoid the burning of the freshly-cut tips by bright sunshine.

It is well to remember that summer shearing tends to check growth and weaken the plants, whereas dormant pruning is more inclined to favour wood production. Summer pruning can thus be practiced on a hedge that is strong, but one that shows signs of weakness should be cut back in winter and left to grow comparatively freely in summer.

The method of trimming hedges generally adopted is to cut the sides first, then the top, allowing the hedge to be somewhat wider at the base than at the top. Trees such as Linden, Beech, Hornbeam, or Chinese Elm should be planted only when high screens are desired.

Hedges as a rule require a space of 3 feet in width at the base to allow for cultivation and ultimate growth. If the space available is too small, then a lattice with a quick growing vine gives a similar effect and will need only 18 inches in width.

"A hedge between keeps friendship green."

ANNUALS

There is a place in farm home grounds for annual flowering plants because of their colour, their many uses for edging, beds, screens, climbers and cut flowers, and their low cost and easy culture.

Any good garden soil will grow annuals; some varieties, such as marigolds and nasturtium, bloom more freely in poor soil.

Some annuals, such as nasturtium, poppy, sweet peas, and mignonette, can be sown outdoors where they are to bloom. Work the soil to good fine condition, then sow seed thinly and mark the place. Thin out the seedlings when they are a few inches high and when the ground is moist.

Other annuals are usually bought about the end of May in small boxes or baskets, then transplanted to their flowering positions. This should be done on a dull day and the newly planted annuals well watered.

Since cutworms take a toll of these young seedlings, it is wise to protect them by a ring of poisoned bait made from 1 quart of bran and 1 teaspoonful of Paris green with enough water to moisten the mixture. Spread around the plants on a warm evening as soon as the plants are set out. Actually cutworm bait is more effective if used after the soil is prepared and before plants are set out.

LIST OF FLOWERING SHRUBS SUITABLE FOR FARM HOMES
ARRANGED ACCORDING TO FOUR SIDES OF A HOUSE

BORDER FACING NORTH

Variety	Ultimate Height	Time of Attractiveness	Description
Berberis Thunbergii (Japanese Barberry)	4'-5'	Red berries in November	Valuable protective shrubs with thorny spines
Viburnum Opulus nanum	1½'-2'	Good appearance throughout season	Dense foliage on compact twiggy shrubs
Symphoricarpos racemosus (Snowberry)	5'6'	White berries in October	Shade and town lover, abundant root system
Symphoricarpos orbiculatus (Coralberry)	5'-6'	Purple fruit in October	Good for shady places, attractive foliage
Ribes alpinum (Alpine Currant)	4'-6'	Yellow flowers in May	Foliage appears early and lasts late; good for towns
Cornus elegantissima (Silver-leafed dogwood)	5'-6'	Red stems in February and March, silver leaves in summer	Attractive shrub throughout the season
Kerria japonica	4'-5'	Yellow flowers in May	Green stems in winter
Hydrangea arborescens (Snowball Hydrangea)	4'-5'	White flowers in July	Blooms better if pruned well back every spring

BORDER FACING SOUTH

Variety	Ultimate Height	Time of Attractiveness	Description
Potentilla fruticosa	2'-3'	Yellow blooms in July and August	Compact neat shrub
Polyantha roses	2'-3'	June to November	Masses of colour on dwarf shrubs
Prunus triloba (Flowering Plum)	4'-5'	Double pink flowers in May	Flowers before leaves appear, very showy
Buddleia (Butterfly Bush)	5'-6'	August to September	Purple-lilac, arching blooms
Weigela florida	6'-8'	May to June	Spreading graceful shrub
Hibiscus (Rose of Sharon)	6'-8'	September	Erect growing, colourful flowers
Rosa Hugonis	4'-5'	Yellow flowers in May	Fern-like foliage, graceful habit
Kolkwitzia amabilis (Beauty Bush)	6'-8'	Pink flowers in June	Vertical growing with arching flowers

BORDER FACING EAST

(All shrubs listed under Northern Border can be used here)

Variety	Ultimate Height	Time of Attractiveness	Description
Spiraea arguta (Garland Flower)	4'-5'	White flowers in April and May	Dainty growth, colours yellow in fall
Spiraea Froebeli (Dwarf Spiraea)	3'-3½'	Rosy crimson flowers in July and August	Dwarf compact shrub
Physocarpus opulifolius aureus (Golden Ninebark)	8'-10'	Dense particles of cream-greenish bloom in June	Arching branches of golden foliage
Spiraea Vanhouttei (Bridal Wreath)	5'-6'	White flowers at end of May	Graceful drooping habit

BORDER FACING EAST cont.
(All shrubs listed under Northern Border can be used here)

Philadelphus coronarius grandiflorus (Mock Orange)	8'-10'	White flowers in July	Erect compact habit
Philadelphus coronarius aureus (Golden Mock Orange)	4'-5'	Flowers in June	Bright yellow leaves; compact globe habit
Chaenomeles sp. (Japanese Quince)	3'-4'	Scarlet flowers in April	Glossy-leaved shrub
Hydrangea arborescens (Snowball-hydrangea)	3'-4'	White flowers in July and August	Round clusters of white flowers, shiny leaves; good in shade
Forsythia intermedia	6'-8'	Yellow flowers in April	Arching habit, flowers before leaves

BORDER FACING WEST

Variety	Ultimate Height	Time of Attractiveness	Description
Lonicera tatarica (Honeysuckle)	6'-8'	June	Pink flowers, red berries in July and August
Berberis	4'-5'	See North list	
Euonymus alata	5'-6'	Colourful leaves in fall	Quaint irregular growth
Acer palmatum (Japanese Maple)	6'-8'	Brilliant colours in leaves all season	Horizontal branches
Philadelphus (in variety)	4'-6'	See East list	
Spiraea (in variety)	4'-6'	See East list	

LIST OF ANNUAL FLOWERS FOR EDGING BEDS AND BORDERS

Name	Height	Colour	Bloom Time	Remarks
Ageratum	6-12"	Blue, mauve	July-frost	Compact
Alyssum, Sweet	4-8"	White, violet	June-frost	Fragrant, cut back at times
Candytuft	12"	White	June-frost	Early bloom, fragrant
Lobelia	4-10"	Blue	July-frost	Inclined to dry up in hot weather
Nasturtium (Dwarf)	12"	various	July-frost	Likes poor soil
Pansy	6-8"	various	May-frost	Keep seed pods picked off
Portulaca	4-6"	various	July-frost	Dry situations
Tagetes (Dwarf)	6-8"	Yellow	July-frost	Long blooming
Petunia	12-14"	various	July-frost	Prolific bloom

FOR BEDS AND BORDER PLANTING

Name	Height	Colour	Bloom Time	Remarks
Aster	30"	various	August-frost	Slow growing
Marigold, French	12-36"	Yellow, orange	July-frost	Reliable
Petunia	12-14"	various	July-frost	Prolific bloom
Phlox Drummondi	12"	various	July-frost	Stands drought well
Verbena	6-8"	various	July-late frost	Slow growing
Zinnia	12-40"	various	July-late frost	Reliable
Celosia	18-24"	Red, yellow, orange	July-frost	Colourful

FOR SCREENS OR HEDGES

Castor Oil Bean	6-10'	Huge green foliage	August-frost	Slow growing
Cosmos	4-5'	various	July-hard frost	Fast growing
Kochia	2-3'	Green foliage	June-frost	Turns red, can be trimmed
Marigold, African	2-3'	Yellow, orange	July-frost	Long season
Datura, Angel's Trumpet	3-4'	White flowers	July-frost	Tender

FOR CLIMBERS

Name	Height	Colour	Bloom Time	Remarks
Cobaea scandens	12-15'	Purple, white	Summer	Rapid Climber
Sweet Pea	4-6'	various	July-frost	Needs deep penetration
Morning Glory	10-12'	Mostly blue	July-frost	Withstands poor soil
Nasturtium (Tall)	4'	Red, yellow	July-frost	Withstands poor soil

FOR CUT FLOWERS

Aster	24-30'	various	August-frost	Slow growing
Cosmos	40-48"	various	July-frost	Fast growing
Gypsophila	18"	White, pink	July-frost	Blooms quickly
Larkspur	12-18"	various	July-frost	Good cut flower
Marigold	12-36"	Yellow, orange	July-frost	Long lasting
Pansy	6-8"	various	May-frost	Keep seed pods picked
Poppy	12-24"	Red, pink, rose, white	June-frost	Sow where to bloom
Salpiglossis	30"	various	July-frost	Slow growing
Scabious	18-24"	various	July-frost	Good cut flower
Stock	24-30"	various	August-frost	Fragrant in evening
Verbena	prostrate	various	July-frost	Slow growing
Zinnia	12-36"	various	July-frost	Reliable

A LIST OF SUITABLE DECIDUOUS TREES FOR FARM HOMES IN ONTARIO

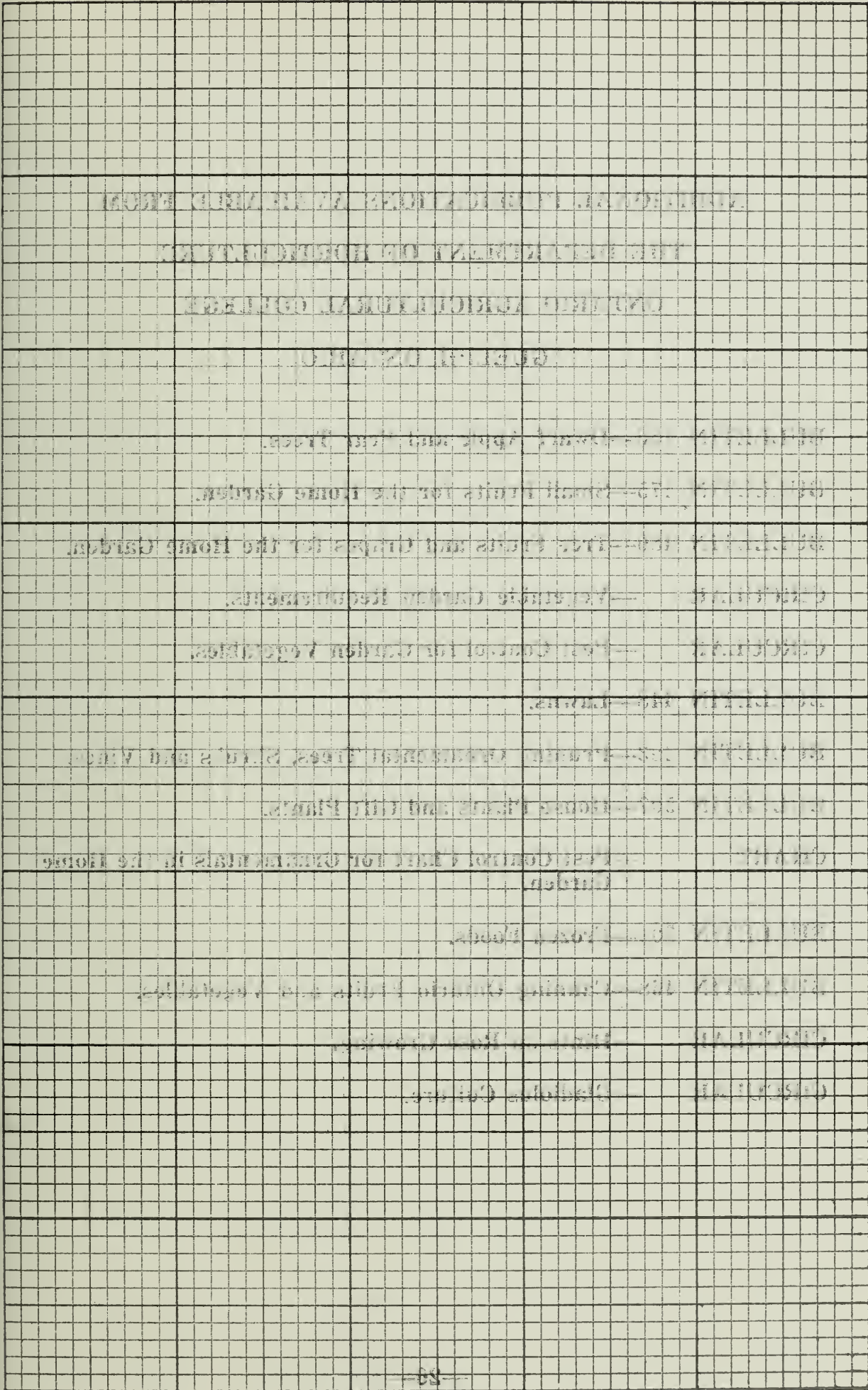
TREES	Ultimate Height	Habitat and Soil Requirements	Root System	Outline	Remarks
1. ACER saccharinum (Soft or Silver Maple)	100'	moist, bottom land	fibrous	broad-topped	half-hardy, brittle, white underleaf
2. ACER saccharum (Hard or Sugar Maple)	100'	well-drained uplands, rich soil	shallow, fibrous	broad, rounded top	maple syrup, fall colouring values
3. ACER platanoides (Norway Maple)	90'	upland, all types of soil	fibrous	globular	very hardy. This is a purple-leaved form that is popular.
4. AESCULUS Hippocastanum (Horse Chestnut)	75'	rich land, deep soil	branching	dome-shaped	spectacular flowering tree
5. BETULA papyrifera (Canoe Birch)	75-80'	rich slopes, sandy loam	branching surface	pyramidal	attractive white bark, graceful, hardy
6. CATALPA speciosa (Western Catalpa)	90'	bottom land, adapted to most soils	branching	broad-topped	large leaves, showy bloom, hardy
7. FAGUS sylvatica (European Beech)	95'	woodlands	surface rooting	horizontal	smooth bark, persistent foliage, hardy
8. FRAXINUS americana (White Ash)	100'	rich slopes and bottom land	inclined to tap root	upright, stately and broad-topped	straight-stemmed, good habits, hardy

A LIST OF SUITABLE DECIDUOUS TREES FOR FARM HOMES IN ONTARIO

TREES	Ultimate Height	Habitat and Soil Requirements	Root System	Outline	Remarks
9. <i>PLATANUS occidentalis</i> (Buttonwood)	120'	streamsides, moist fertile soil	branching, fibrous	spreading	mottled bark, hardy
10. <i>QUERCUS rubra</i> (Red Oak)	90"	well-drained soil, gravelly loam	deeply anchored tap root	wide and horizontal	very hardy, majestic, rugged
11. <i>QUERCUS palustris</i> (Pin Oak)	70'	borders swamps, deep rich soil	tap root	pyramidal	smooth bark, low-branching, hardy
12. <i>SALIX babylonica</i> (Weeping Willow)	50'	streamsides, moist soil	fibrous	arching	graceful, year-round beauty
13. <i>SORBUS aucuparia</i> (Mountain Ash)	30'	swampy regions, adapted to all soils	branching	ovoid	outstanding for its fruit and attractive foliage
14. <i>TILIA americana</i> (American Linden)	100'	slopes and bottom land, rich soil	branching, fibrous	heart-shaped	fragrant, symmetrical, somewhat tender, many uses
15. <i>ULMUS americana</i> (American Elm)	125'	moist bottomlands, rich loam	far-reaching	vase-shaped	brittle, very graceful, hardy

COLOUR						PERENNIALS	HEIGHT (in feet)					SEASON				
YELLOW	WHITE	PINK	RED	BLUE	PURPLE		1	2	3	4	5	MAY	JUNE	JULY	AUGUST	SEPTEMBER
			■			ACONITE Monkshood			■	■				■	■	■
■	■	■	■	■	■	AQUILEGIA Columbine	■	■				■	■			
	■	■	■			ASTILBE Meadowsweet	■	■	■				■	■		
	■			■		CAMPANULA Bellflower	■	■	■				■	■		
	■					CHRYSANTHEMUM Shasta Daisy Maximum		■	■				■	■	■	
■						COREOPSIS Tickseed		■					■	■	■	
	■	■		■	■	DELPHINIUM Larkspur		■	■	■	■		■	■	■	■
		■				DICENTRA Bleeding Heart		■	■			■	■			
■						DORONICUM Leopard's Bane		■	■			■	■			
■			■			GAILLARDIA Blanket Flower		■				■	■	■	■	■
■						HELENIUM Helen's Flower			■	■	■				■	■
■						HELIOPSIS Orange Sunflower			■	■				■	■	■
■						HEMEROCALLIS Day Lily		■	■	■			■	■	■	
	■			■	■	HOSTA Plantain Lily	■	■					■	■	■	■
■	■	■		■	■	IRIS Bearded and Japanese	■	■	■			■	■	■		
					■	LIATRIS Blazing Star			■	■				■	■	■
	■	■		■	■	LUPINUS Lupine			■	■			■	■		
			■			MONARDA Bergamot				■			■	■		
■			■			OENOTHERA Evening Primrose	■	■					■	■		
	■	■	■		■	PEONY		■	■	■			■			
	■	■	■			PAPAVER Oriental Poppy			■			■	■			
	■	■	■		■	PHLOX Flame Flower		■	■					■	■	■
■	■	■	■		■	PRIMULA Primrose	■	■				■	■			
■						RUDBECKIA Black-Eyed Susan		■	■					■	■	■
■						TROLLIUS Globe Flower		■				■	■	■		
	■			■		VERONICA Speedwell	■	■				■	■	■	■	

“USE THIS GRAPH PAPER FOR A SCALE PLAN OF YOUR PLANTING AREA”



ADDITIONAL PUBLICATIONS AVAILABLE FROM
THE DEPARTMENT OF HORTICULTURE
ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

BULLETIN 456—Dwarf Apple and Pear Trees.

BULLETIN 475—Small Fruits for the Home Garden.

BULLETIN 480—Tree Fruits and Grapes for the Home Garden.

CIRCULAR —Vegetable Garden Requirements.

CIRCULAR —Pest Control for Garden Vegetables.

BULLETIN 448—Lawns.

BULLETIN 483—Pruning Ornamental Trees, Shrubs and Vines.

BULLETIN 507—House Plants and Gift Plants.

CHART —Pest Control Chart for Ornamentals in the Home
Garden.

BULLETIN 504—Frozen Foods.

BULLETIN 468—Canning Ontario Fruits and Vegetables.

CIRCULAR —Hints on Rose Growing.

CIRCULAR —Gladiolus Culture.



CA2ΦNAF6
B522

INSECTS ATTACKING VEGETABLES

ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

Dr. C. D. Graham
Deputy Minister

Honourable W. A. Goodfellow
Minister

CONTENTS

Page

INTRODUCTION	6
Control Sections	6
Home-garden Recommendations	7
Insecticides	8
Spray Equipment	8

CAUTION

Residue Tolerances	9
--------------------------	---

ACKNOWLEDGMENTS	10
------------------------------	----

GENERAL FEEDERS	11
------------------------------	----

Aphids	11
Crickets	17
Cutworms	13
European Earwig	30
Grasshoppers	16
Millipedes	28
Nematodes	26
Slugs	24
Sowbugs	29
White Grubs	21
Wireworms	18

ASPARAGUS

Asparagus Beetle	32
Spotted Asparagus Beetle	34

BEANS

Seed-corn Maggot	34
Mexican Bean Beetle	38
Leafhoppers	40
Bean Weevil	40
Two-spotted Spider Mite	42
Other Insects of Beans	44

BEET, INSECTS of	45
CABBAGE, CAULIFLOWER, and RELATED CROPS	
Cabbage Maggot	46
Striped Flea Beetle	49
Cabbage Aphid	51
Turnip Aphid	51
Cabbage Caterpillars	52
Imported Cabbageworm	52
Diamondback Moth	54
Cabbage Looper	55
Zebra Caterpillar	62
Other Insects of Cabbage and Related Crops	63
CARROT and PARSNIP	
Carrot Rust Fly	63
Six-spotted Leafhopper	65
Other Insects of Carrot and Parsnip	65
CELERY	
Tarnished Plant Bug	66
Celery Leaf Tier	68
Celery Looper	68
Other Insects of Celery	67
CORN	
European Corn Borer	68
Corn Earworm	71
Chinch Bug	73
Corn Flea Beetle	74
Billbugs	74
Corn Leaf Aphid	74
Corn Rootworms	74
Other Insects of Corn	74
CUCUMBER, MUSKMELON, SQUASH, PUMPKIN	
Striped Cucumber Beetle	75
Spotted Cucumber Beetle	77
Squash Bug	78
Squash Vine Borer	80
Melon Aphid	82
Other Insects of Cucurbits	83

EGGPLANT, INSECTS of 84

LETTUCE

 Six-spotted Leafhopper 84

 Other Insects of Lettuce 86

ONION

 Onion Maggot 87

 Onion Thrips 89

PEA

 Pea Aphid 91

 Pea Weevil 94

 Pea Moth 96

 Other Insects of Pea 97

PEPPER, INSECTS of 97

POTATO

 Colorado Potato Beetle 98

 Potato Flea Beetle 99

 Potato Leafhopper 101

 Potato Aphids 102

 Blister Beetles 104

 Potato Scab Gnat 104

 Common Stalk Borer 104

 Other Insects of Potatoes 103

RHUBARB

 Rhubarb Curculio 105

SPINACH

 Spinach Leaf Miner 106

 Other Insects of Spinach 108

TOMATO

 Tomato Hornworm 108

 Tobacco Hornworm 108

 Tomato Russet Mite 111

 Flea Beetle 111

 Tomato Fruitworm 112

 Stink Bugs 113

 Other Insects of Tomato 113

INSECTS ATTACKING VEGETABLES

by

H. W. GOBLE

Department of Entomology and Zoology,
Ontario Agricultural College, Guelph, Ontario

INTRODUCTION

In this bulletin an attempt has been made to bring together information on the habits, life history, and control of the important insects and mites, and of a few other animal pests such as slugs, of the vegetable crops important to Ontario. A few insect species that have been less important are included with short outlines concerning them.

The write-up on each pest has been prepared basically for the commercial vegetable grower and those who advise in the control of insects and related pests. The insects are discussed under the crop on which they generally are most important; for example, the tarnished plant bug is given under Celery, although it attacks many other crops. Pests that attack a very wide range of plants, such as white grubs and wireworms, are grouped under General Feeders. The life histories of the various pests have been given to assist in the planning of satisfactory controls. The reader is advised to consult text books in entomology if more detail is required. The illustrations show, as much as possible, the injury and stages of the pests that growers should be able to identify. Insect developmental stages which cannot be readily seen and stages which need not be identified to carry out an intelligent control program are rarely illustrated.

Control Sections

The section on control under each insect is general and short. Experience in chemical control since the common use of DDT indicates that materials and methods of applying them based on research and grower use will change slightly from year to year. Thus many new materials that have not been tested many years have not been included. Information concerning their use as well as that of the longer-tested insecticides will appear each year in the current Ontario Protection

Calendar for Vegetables, prepared by the Ontario and Canada Departments of Agriculture. Insects that attack turnips and potatoes will be in the outline Control of Insects and Diseases of Field Crops. All of these control guides are available each spring from the Ontario Department of Agriculture Extension Service.

Home-garden Recommendations

For almost all of the insects, the rate of application of insecticides has been given for 100 gallons of spray or for 1 acre of vegetables. The home gardener may purchase insecticides either as dusts or sprays in small containers for vegetable crops. The rate of application for 1 to 3 gallons of spray is usually given on the label, as is the amount of dust required. If you wish to use the recommendations given in this bulletin, the following is a rough conversion guide.

If the Amount of SPRAY recommended for 100 gallons is	The equivalent rate to make 1 gallon of spray is
1 pound of dry insecticide (wetable powder, etc.)	1 tablespoonful
1 quart of liquid insecticide (emulsifiable, etc.)	2 teaspoonfuls

Adjust rates for other recommendations in proportion; for example, use 2 tablespoonfuls for 1 gallon of spray if the recommended rate is 50 per cent wettable powder 2 pounds to 100 gallons.

If the Amount of DUST recommended per acre is	The equivalent rate for 1000 square feet is
30 pounds	$\frac{3}{4}$ pound
40 pounds	1 pound
100 pounds	2½ pounds

Adjust rates in proportion for other recommendations.

Insecticides

Insecticides for vegetables have been greatly improved during the last few years. However, some difficulties have arisen such as compatibility with the fungicides and, occasionally, injury to the plant under conditions of wet foliage, high humidity, and extreme heat. Some plants such as cucurbits and occasionally tomatoes are prone to insecticide injury. Many outlines and books give more information on insecticides.

The amounts of insecticides given in this bulletin, with a few exceptions such as seed dressings and poison baits, are for 100 gallons of spray or for 1 acre of crop. Dusts and granular types are given on an acre basis.

Spray Equipment

Equipment that will apply the correct amount of insecticide at the right time is just as important as the material used. Row-crop sprayers and dusters require wheels that may be adjusted to fit the width of the vegetable rows; as an alternative, the crop may be planted so that the distance between the rows fits your machine. High-clearance machines are necessary for corn. Airplane application is satisfactory for many crops.

CAUTION

Before using insecticides, read carefully and follow the cautions given by the manufacturer concerning the safe handling of sprays and dusts. Use recommended masks where required to prevent breathing poisonous materials. Do not work in the drift of sprays or dusts. Wash thoroughly with soap and water after working with insecticides.

All the materials recommended are poisonous. Parathion and TEPP are deadly poisons. For the safe handling of these materials, carefully follow all warnings which are found in every carton and on every container. Do not work in parathion-treated fields until the safe period from treatment has elapsed. Be especially careful not to work in the spray or dust drift of dieldrin or endrin as these also are highly toxic.

Residue Tolerances

The Food and Drug Directorate at Ottawa has the responsibility of establishing the maximum safe limit of insecticide residue on the edible parts of plants. Marketable food crops must be below this maximum residue. Recommendations given by the Canada and Ontario Departments of Agriculture and the manufacturers of insecticides will give the length of time required from the last insecticide treatment until harvest in order that the residue be below the maximum. At time of writing, these legal tolerances are being established, thus only a few examples are given. It is expected that the time required between treatment and harvest for DDT will be at least 30 days, whereas with TEPP, since its residues disappear quickly, it is likely to be three days. The period required for malathion will be short, probably about seven days. There may be no restrictions on a material like rotenone. **Follow the direction label** carefully for all insecticides in order that your marketable food crops will contain less than the maximum insecticide residue allowed by law.

ACKNOWLEDGMENTS

The author is very indebted to entomologists of Science Service of the Canada Department of Agriculture, and the Department of Entomology and Zoology of the Ontario Agricultural College for reviewing sections of this bulletin. The following assisted greatly:

G. F. Manson, H. B. Wressell, L. A. Miller, and J. A. Begg, Laboratory of Entomology, Chatham.

W. G. Matthewman, D. G. Harcourt, and G. H. Hammond, Laboratory of Entomology, Ottawa.

W. E. Heming, W. C. Allan, and J. G. Oughton, Department of Entomology and Zoology, Ontario Agricultural College, Guelph.

Photographs were kindly supplied for the following illustrations by:

Science Service, Canada Department of Agriculture—Fig. 2, 4, 8, 12, 19, 28, 30, 31, 35, 45.

Geneva Agricultural Experiment Station, N.Y.—Fig. 27, 34, 36.

Cornell University, N.Y.—Fig. 32.

North Carolina State College—Fig. 3, 35.

Photographs other than those listed above were taken by the Photographic Division, Department of Public Relations, Ontario Agricultural College.

GENERAL FEEDERS

APHIDS

Aphids of various species attack many of the vegetable crops. Although many of them are named after the crop on which they are most troublesome, such as the melon aphid on melons, they may infest and injure others.

Aphids are small, soft-bodied insects that suck the sap from the plants. Many species are green but they vary in colour, with the bean aphid being black and the potato aphid green with a pinkish tinge. Examples of a winged and wingless aphid are shown in Plate A, page 56. Most individuals of an aphid population are wingless, but winged females and males are present at certain times.

Plants Attacked

All vegetables are subject to attack. Cucumbers, melons, cole crops, peas, and peppers have serious aphid pests.

Injury

Both nymphs and adults suck the sap from the plants. All parts, including the root, may be attacked, depending on the species. They may cause blasted buds, dimpled fruit, and curled leaves, and the foliage usually becomes pale and sickly. Heavily infested plants may die. Also, the aphids leave a sticky material on the plant known as honeydew, in which a black, sooty fungus may grow. Insects contaminate the edible parts of some crops, particularly types such as spinach and broccoli. They are very important in the transmission of virus diseases.

Life History

Aphids typically spend the winter as eggs on some perennial or on the dead remnants of annual plants. The eggs are small, ovate, and shiny black, and are glued on their sides, often near the buds. They hatch in the spring to nymphs that develop into wingless females called stem-mothers. These adults give birth to living young which produce a second generation of wingless females. Soon winged females appear which may fly either to new plants of the same species or to other host plants. Winged forms appear throughout the summer along with wingless types, all being females. A greater percentage of winged females develop if

they become crowded on one plant, and these fly to new plants. Development is very rapid when it is hot. In the fall, winged males and females develop and mate, and eggs are laid on the winter host plants. There are many generations during the season.

Aphids are parasitized very commonly by various insects, particularly by some of the small parasitic wasps known as chalcids and braconids. Lady beetle adults and larvae, Plate B, page 56, syrphus fly larvae, lacewing adults and larvae, and other insects prey on aphids. These and other natural factors often keep aphid populations low but, in spite of them, periodically there are outbreaks.

Control

The control for aphids on many of the crops has been given throughout the bulletin. Many new materials are being tested against aphids, thus it is recommended that growers follow each year's Protection Calendar for Vegetables for up-to-date control on each crop. The following are some standard recommendations for sprays and dusts.

Sprays. Use one of the following materials. The rate given is for one acre of crop.

- (1) 25 per cent malathion wettable powder 4 pounds
- (2) 50 per cent malathion emulsifiable 1½ pints
- (3) 40 per cent TEPP liquid ½ pint
- (4) 15 per cent parathion wettable powder 2 pounds
- (5) 25 per cent parathion emulsifiable 1 pint
- (6) 40 per cent nicotine sulphate 2 pints plus 5 pounds of dissolved laundry soap.

Use only malathion or nicotine sulphate sprays in home gardens and hand sprayers. Follow all safety precautions, particularly when you use parathion or TEPP.

Dusts. Use one of the following at 30 to 40 pounds per acre:

- (1) 4 per cent malathion dust
- (2) 1 per cent parathion dust
- (3) 1 per cent freshly made TEPP dust.

Sprays and dusts of these materials are more effective when temperatures are 70°F. or higher and when it is calm. Often more than one application is required.

CUTWORMS

Many different species of cutworms attack vegetable crops. Cutworms occur throughout agricultural Ontario, although the species may vary in the different areas.

The adults are medium-sized, dull-coloured moths, often called "millers", that fly mostly at night (Fig. 1). The larvae, or cutworms, are fleshy, soft-bodied, dull-coloured caterpillars that lie curled near the surface of the soil. The markings on both the adults and larvae vary with the species. Two types of cutworms are shown in Figure 2.

Plants Attacked

Cutworms feed on nearly all plants except those with hard, woody stems. Vegetables particularly subject to cutworm injury are tomato, pepper, cabbage, cauliflower, corn, lettuce, and bean.

Injury

Cutworms usually chew the plants off at ground level. One specimen may destroy more than one plant, thus they often cause serious damage to transplanted crops. Some are climbing types that feed on the leaves, while the second generation of the variegated cutworm may attack the fruit of tomatoes. Usually the injury is most serious in May and June, when the plants are small.

The armyworm is a species of cutworm that has the habit of moving from one field to another. It attacks grain, grass, and corn in particular.

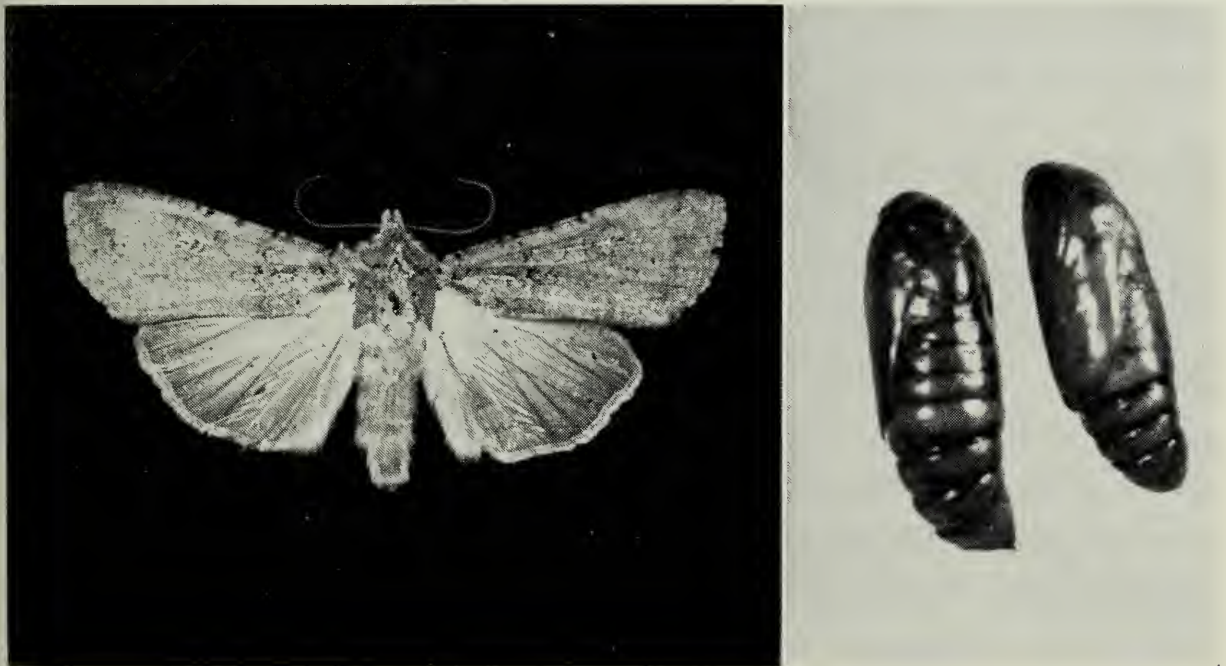


Fig. 1. Cutworm moth and its pupae.

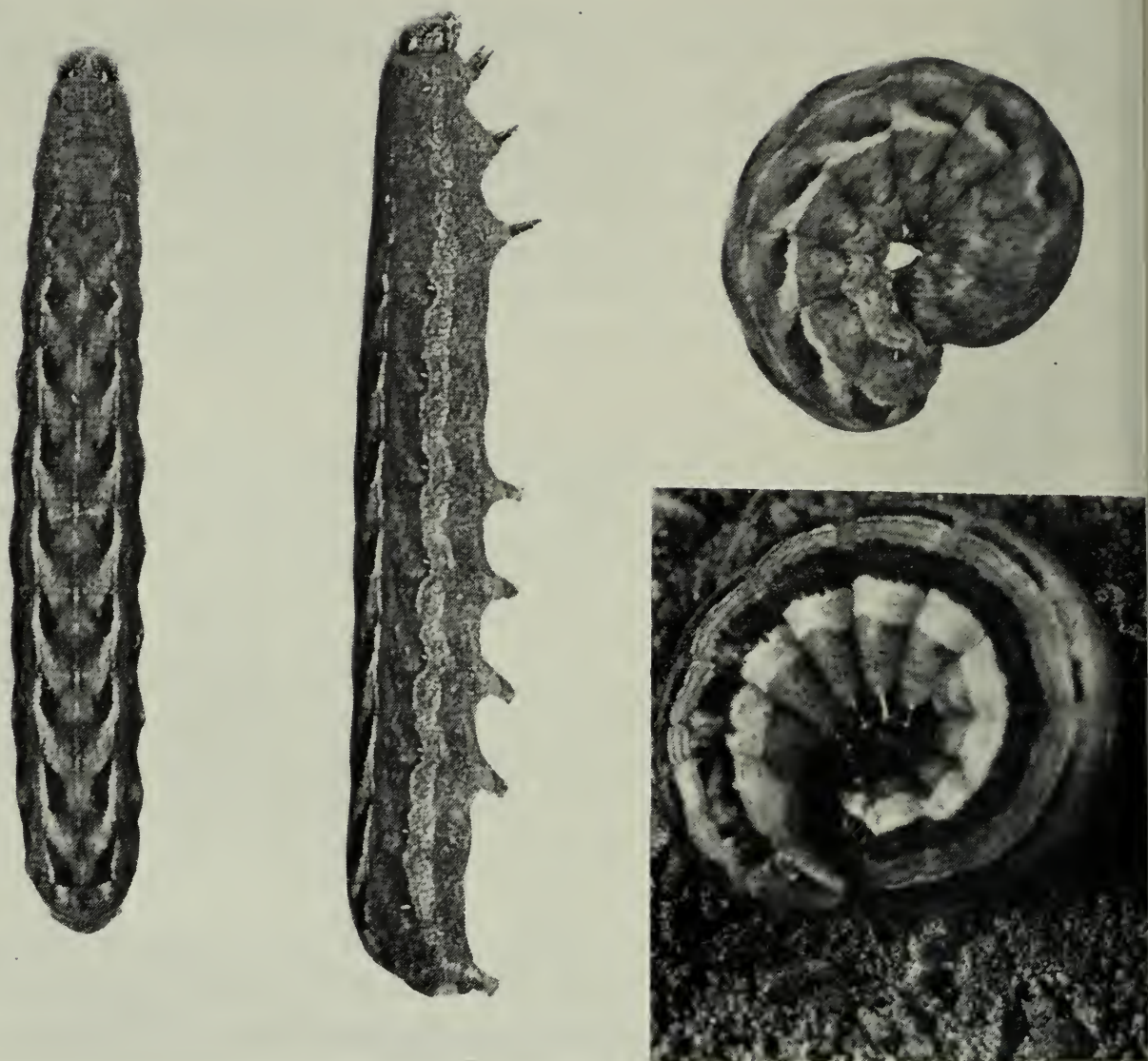


Fig. 2. Cutworm showing dorsal and side view and curled position. Inset, an armyworm.

Life History

Most species of cutworms spend the winter as partly grown or mature larvae in earthen cases in the soil. They feed early in the spring and continue to grow until mature, at which time they pupate in the soil. The moths emerge and lay eggs in various locations, depending on the species. Some deposit them on the stems of weeds and grasses while others place them on or in the soil. The eggs hatch in from two days to two weeks, and the larvae lie in the soil near the surface or under plant debris during the day and feed at night. The larval stage may extend from two weeks to five months. Most of the species have one generation a year, while others have two to four.

Control

1. Usually cutworms will not be present in an area that was under clean cultivation during the last part of July and in August of the preceding year.

2. Before-planting soil treatment. Apply aldrin or heptachlor to the soil at a rate to give two pounds of actual chemical to the acre. Work it into the top three or four inches of soil.

3. Sprays and dusts. If cutworms are found after planting, spray or dust with aldrin, heptachlor, or toxaphene at a rate to give two pounds of actual chemical per acre, or apply 5 per cent DDT dust at 40 pounds per acre.

4. Poison bait. While poison bran bait may require more time for application it is likely to cost the least. Also it may be used on tomatoes and some other crops at or near harvest when sprays and dusts would leave residues on the fruit. The formula for about 4 acres is 100 pounds of bran plus one of the following amounts of actual chemical: aldrin 1½ pounds, dieldrin 1½ pounds, chlordane 2 pounds, heptachlor 1½ pounds, or toxaphene 3 pounds. It will require about 8 gallons of water to moisten it.

To prepare the bait, mix the poison thoroughly with the bran by shovelling over on a smooth, concrete floor. Add water to the mixture and shovel again until all is moist. If a liquid concentrate type of insecticide is used, it may be added to the water first, and thus one saves one shovelling operation. Spread the bait during the evening of a warm day, either by hand or with spreading equipment.

5. Home gardens. Because of availability in small quantities and ease of application, the preferred method is to dust the surface of the soil along the rows after planting with a 2 to 5 per cent dust of aldrin, chlordane, dieldrin, heptachlor, or DDT.

GRASSHOPPERS

Grasshoppers usually are not important in vegetable production. However, where vegetables are grown in fields adjacent to grass sod, the insects sometimes move to the vegetable crop. There are several species, but the red-legged grasshopper and the migratory grasshopper often comprise most of the population. The two-striped grasshopper and the Carolina grasshopper are usually present in smaller numbers.

The nymphs, or young, look like the adults but lack fully developed wings. Both are shown in Figure 3.

Plants Attacked

Almost all vegetables are attacked but grasshoppers seem particularly partial to tomato and corn.

Injury

They feed on the leaves mostly but may feed on any part of the plant above ground.

Life History

The winter is spent as eggs in pod-like containers deposited in the ground in pastures and waste land, and along ditch banks and fence rows. These hatch in May or early June to nymphs which feed usually on grain, grass, and corn. The nymphs moult as they grow and become adults in July and August. These are the forms that move most readily to vegetable crops. The females lay eggs in the pod-like sacs in August and September. There is one generation a year.

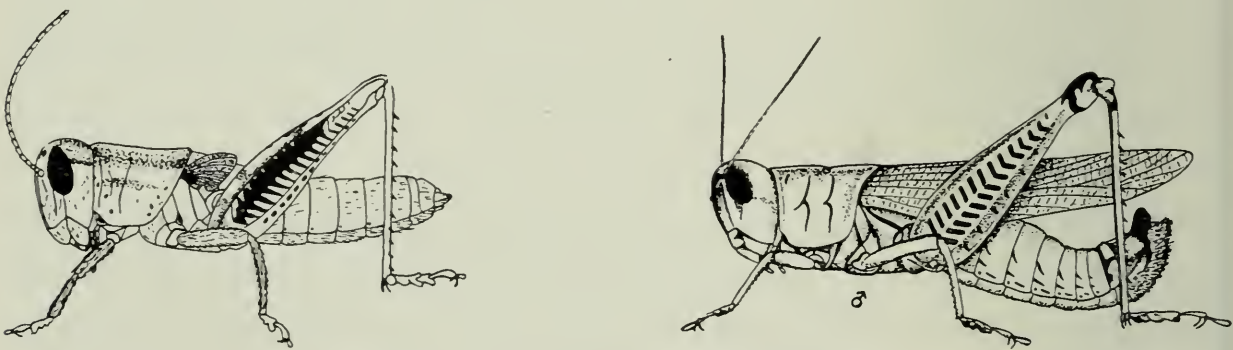


Fig. 3. Grasshopper nymph and adult.

Control

1. Follow a short crop rotation.
2. If it is practical, plough fence rows and waste land in the fall and work the soil thoroughly.
3. Sprays and dusts. Where possible, spray or dust infested fields adjacent to vegetable crops. Treating the fence rows only will assist in control. The vegetable crop itself may be sprayed or dusted provided there is sufficient time between treatment and harvest. Use one of the following materials, applying the amount of actual insecticide given per acre: aldrin 4 to 6 ounces, chlordane 1 pound, dieldrin 2 ounces, heptachlor 4 to 6 ounces, or toxaphene 1 to 1½ pounds. If the vegetation is thick or if you use dusts, apply the heavier rate where a choice of 4 to 6 ounces or 1 to 1½ pounds is given. For formulations and methods of obtaining the correct amount per acre, see under Wireworms on page 18.
4. Poison bait. A bran bait may be prepared as described under Cutworms on page 13 and applied at 25 pounds to the acre. The following are the poisons and the amount of actual chemical to add to 100 pounds or bran: aldrin 5 ounces, chlordane 1 pound, dieldrin 2 ounces, or toxaphene 1 pound. The poison bait is not so effective as sprays or dusts if the growth is lush. However, they may be used where sprays and dusts might produce too much residue on the crop.

CRICKETS

Crickets, particularly the field cricket, *Acheta assimilis* F., sometimes cause trouble in tomato fields where they feed on the fruit. Usually they are not so important as grasshoppers.

The habit and life history are similar to those of grasshoppers. Use the same control methods given for grasshoppers.

WIREWORMS

Many species of wireworms may be found in all soil types throughout Ontario. They are one of the most injurious groups of soil-infesting insects.

The adults are known as click beetles because they have snapping structures on the ventral side with which they are able to flip themselves over if they find themselves on their backs. The adults are usually brown or grey, one-quarter to one-half inch long, and of the form shown in Figure 4.

Plants Attacked

Most agricultural plants are attacked. Some of the vegetable crops that are particularly subject to severe injury are potato, corn, transplanted crops such as tomato and cabbage, and most of the root crops.

Injury

Wireworms attack the roots of almost all vegetable crops. Plants attacked before or as they come up are usually killed. Crops such as potatoes and carrots suffer more serious injury near harvest, when the wireworms eat tunnels in the roots or tubers (Fig. 5).

Life History

The life cycle of the many different species of wireworms varies slightly, but in general it is as follows: They winter mostly as larvae (wireworms) or as adults in the soil. The adults fly in the spring and lay eggs in the soil; many species lay near the roots of grass. In a few days to a few weeks these hatch to larvae, the stage from which they get the name wireworms. The larvae require from a year to five years or more to complete their development. They go down deeper in the soil each fall and come up to feed on the roots in the spring and summer. During the late summer of their last year of development they form a cell in the soil and pupate in it, change to adults, and remain in the ground until the following spring. The length of a complete life cycle may be from one to six years, depending on the species.

Control

1. Cultural control. In some soil types, wireworms are usually not a problem where short rotation of crops is practised. This is particularly true if grass is not included in the rotation. However, this method will not control wireworms in areas such as the sandy soils of southern Ontario.



Fig. 4. Click beetle, greatly enlarged; and its larvae, the wireworms, in corn seed.

2. Chemical control. Treat for wireworms where there is a known infestation or in fields where there was injury from them the preceding year. You may use soil treatment for any of the vegetable crops, seed treatment for some, or insecticide in the transplant water for transplanted crops. Use the method that is most suitable to the crop that requires protection.

(a) Before-planting soil treatment. Aldrin, dieldrin, or heptachlor will give effective control of wireworms. For best results, apply it the year before vegetables are planted or, if this is not possible, make application as soon as the land is ready to work in the spring. Apply granular formulations with a seed drill or fertilizer spreader or, for small areas, a hand grass seeder may be used. Dusts will give satisfactory control but are more difficult to apply. Mix wettable powder or emulsifiable formulations with water and spray them on the soil surface. Regardless of the method used in applying the insecticide, work it into the top three to six inches of soil **immediately** after application. The following are the amounts of actual insecticide recommended per acre with the amount of the commonly available formulations required to obtain these:

Aldrin 3 to 5 pounds actual per acre (50 per cent wettable powder 6 to 10 pounds, "20" emulsifiable $1\frac{1}{2}$ to $2\frac{1}{2}$ gallons, or 5 per cent granular or dust 60 to 100 pounds).

Dieldrin $2\frac{1}{2}$ to 5 pounds actual per acre (50 per cent wettable powder 5 to 10 pounds, "20" emulsifiable $1\frac{1}{4}$ to $2\frac{1}{2}$ gallons, or 5 per cent granular 50 to 100 pounds).

Heptachlor $2\frac{1}{2}$ to 5 pounds actual per acre (25 per cent wettable powder 10 to 20 pounds, "2E" emulsifiable $1\frac{1}{4}$ to $2\frac{1}{2}$ gallons, 5 per cent granular or dust 50 to 100 pounds).

Heavily infested, heavy, and muck soils require the higher rate of application.

Granular formulations may be mixed with fertilizer and both applied in one operation provided the correct amount of material is used for each crop and the placement of the insecticide is proper. This method is not recommended for potatoes if the fertilizer is to be placed beside or below the seed piece.

(b) Seed Treatment. Corn or beet seed may be treated with a 50 percent wettable powder of either lindane, dieldrin, aldrin, or heptachlor at the rate of 2 ounces of the wettable powder per bushel of corn or to 25 pounds of beet seed. If you use other formulations, such as 25 per cent wettable powder, apply to give 1 ounce of actual insecticide per bushel of corn or 25 pounds of beet seed.

(c) Planting water treatment. Add 50 per cent lindane wettable powder $\frac{1}{2}$ ounce to 40 gallons of transplant water and apply 4 to 5 fluid ounces per seedling hole when you transplant cabbage, cauliflower, or tomato in the field.



Fig. 5. Left: wireworms projecting from a potato and wireworm injury; right: a white grub and its injury to potato.

WHITE GRUBS

Phyllophaga spp.

White grubs are, like wireworms, one of the most destructive soil-infecting insects. About 25 species occur in Ontario but only a few are economically important. While the damage they cause is very severe in some areas, in others such as Essex and Kent counties they have not been so important.

The adult is the well-known June beetle, while the larva is called a white grub. Both are shown in Figure 6.

Plants Attacked

By the adult—Oak, elm, basswood, large-toothed aspen, aspen poplar, butternut, birch, hawthorn, ash, walnut, willow, raspberry, rose, and many other broad-leaved trees and shrubs.

By the white grub (larva)—The white grub eats the roots of nearly all plants. Some preferred host plants are grass, grain, potato, strawberry, gladiolus, corn, nursery stock, and forestry seedlings.

Injury

As mentioned previously, June beetles, the adults, eat the leaves of many broad-leaved trees and shrubs, although they do not attack vegetables, and the white grubs eat the roots of nearly all plants. These grubs typically cut the main stem or roots of transplants or seedlings so that they wilt and die. During the summer and early fall they eat gouges from the main roots of root crops such as carrots and turnips and from potato tubers (Fig 5).

Life History

White grubs take three years to complete their developemnt, with three larval, or grub, stages. However, typically one of the three predominates greatly over the other two, giving us what is called the “flight” year, followed by the “two-year-grub” year, and then a year with little damage from either grubs or beetles. To illustrate, the following is the dominant cycle at Guelph and of most of central and eastern Ontario, as illustrated by the 1956 to 1959 brood.

There was a "flight" year in 1956. The beetles were very abundant in late May and June and laid many eggs in the soil, particularly in grassy areas. The eggs hatched in about a month and the grubs feed throughout the remainder of the season. They were still small when they moved down into the subsoil for winter, thus there was very little damage in 1956 from the first-year grubs. In the spring of 1957 they will move up and continue to feed and grow rapidly throughout the season, making it the "two-year-grub" season. There will be considerable damage to the roots of many plants. In the fall of 1957 they will again move down into the subsoil for winter. Some will come up in the spring of 1958 and feed on roots to a small extent, while others will stay in the subsoil to complete their development. Damage is not severe the third year. They will pupate in midsummer and change to adults late in the summer, but will remain in the soil until the beetle flight in 1959. Thus, unless there is a change in the cycle, most severe damage from grubs is expected at Guelph and in most of central and eastern Ontario in 1957, 1960, and in three-year periods from 1960. The next "flight" year is predicted for 1959.

The Niagara Peninsula and a small area near Lake Ontario from near Oshawa almost to Burlington have the dominant cycle a year ahead of the rest of the Province. The broods apparently overlap in a strip about

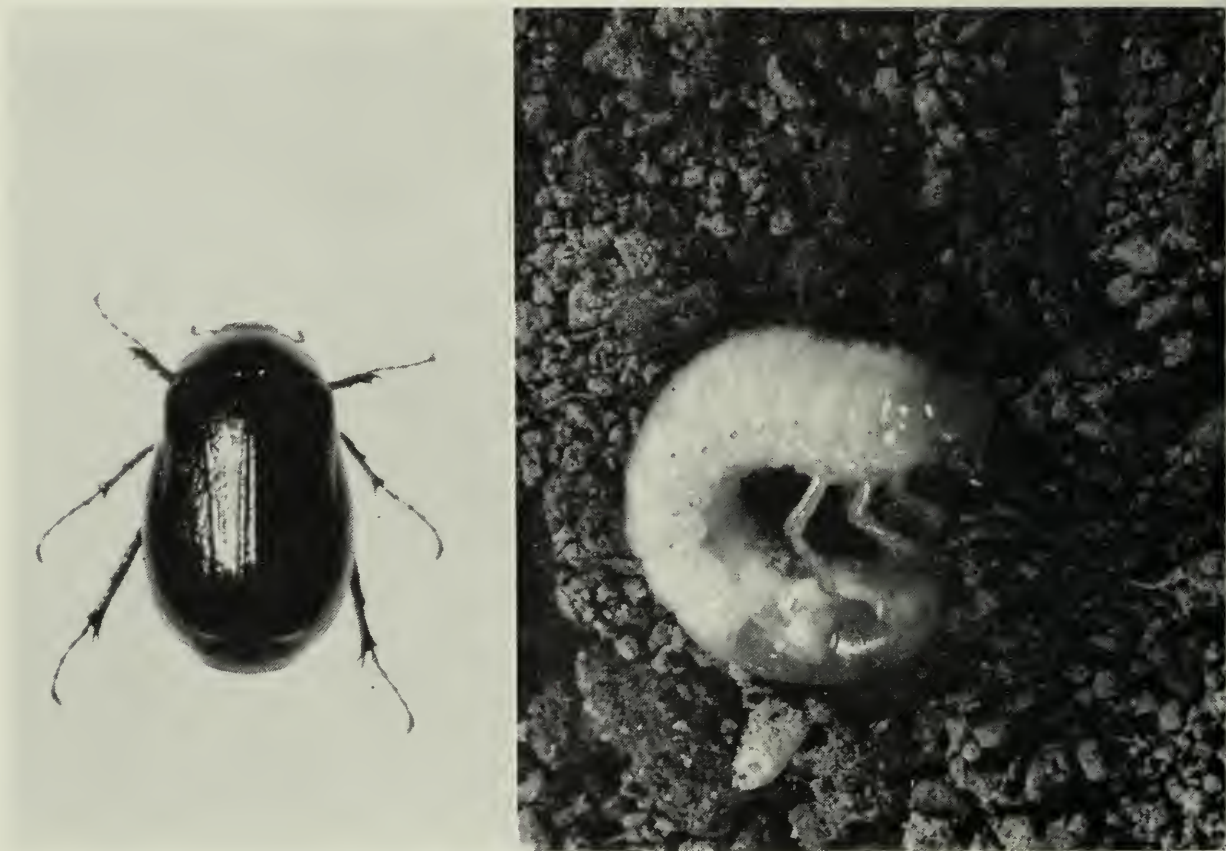


Fig. 6. June beetle and its larva, the white grub.

five to ten miles north of Lake Ontario because growers there have moderately heavy grub damage two out of three years.

Control

1. Use a short rotation of crops.
2. Fertilize well because grubs appear to cause less damage in good soil.
3. Plant susceptible vegetable crops on land known to be free from grubs or that was under cultivation during May and June of the "flight" year.
4. Soil treatment. Apply aldrin, chlordane, dieldrin, or heptachlor to the soil in the spring before planting using the following rates of actual chemical per acre: aldrin 4 to 6 pounds, chlordane 10 pounds, dieldrin 4 to 6 pounds, or heptachlor 4 to 6 pounds. Use the heavier rate for each insecticide on heavy or muck soil or where white grubs are numerous. Formulations of most of these insecticides and methods of application are given under Wireworms on page 18. Be sure to work the materials into the soil immediately after application.

White grubs are more difficult to kill with chemicals than are wireworms and cutworms, thus the rate of chemical recommended for white grubs will control all three of these pests.

Lindane and BHC are effective insecticides for soil treatment for white grubs on many crops but are not recommended for vegetables. One of these may be used at a rate to give 3 to 5 pounds of lindane (actual) per acre, or its equivalent in BHC, on sod areas such as golf fairways, parks, and lawns.

5. A cultural method is to plough infested fields not more than three to four inches deep and then use a multiple-disking operation to kill as many grubs as possible. Work the soil at least three times with a double disk-harrow, one operation going crossways of the field. Birds and other predators also will kill many grubs when they are thus exposed.

SLUGS

Slugs cause considerable damage to plants in Ontario. The most common and destructive are the grey garden slug, *Arion circumscriptus* Johnston, and the brown slug, *Deroceras reticulatum* (Müller). Generally, slugs have not been a great problem in commercial vegetable production; on the occasions when they have, the growers have not recognized the injury. They are considered by the author to be by far the most serious of all pests in home gardens described in this bulletin.

Slugs, although not insects, are included with a few other animal pests that are injurious to vegetables. They are grey or greyish-brown, slimy, legless, soft-bodied pests (Fig. 7). A shiny, silvery trail is left where they have moved.

Plants Attacked

A great many plants are hosts. Some vegetable crops especially susceptible to injury are cabbage, cauliflower, bean, lettuce, the fruit of tomato, potato tubers, and pepper. Annual flowers and rock-garden plants are often seriously injured.

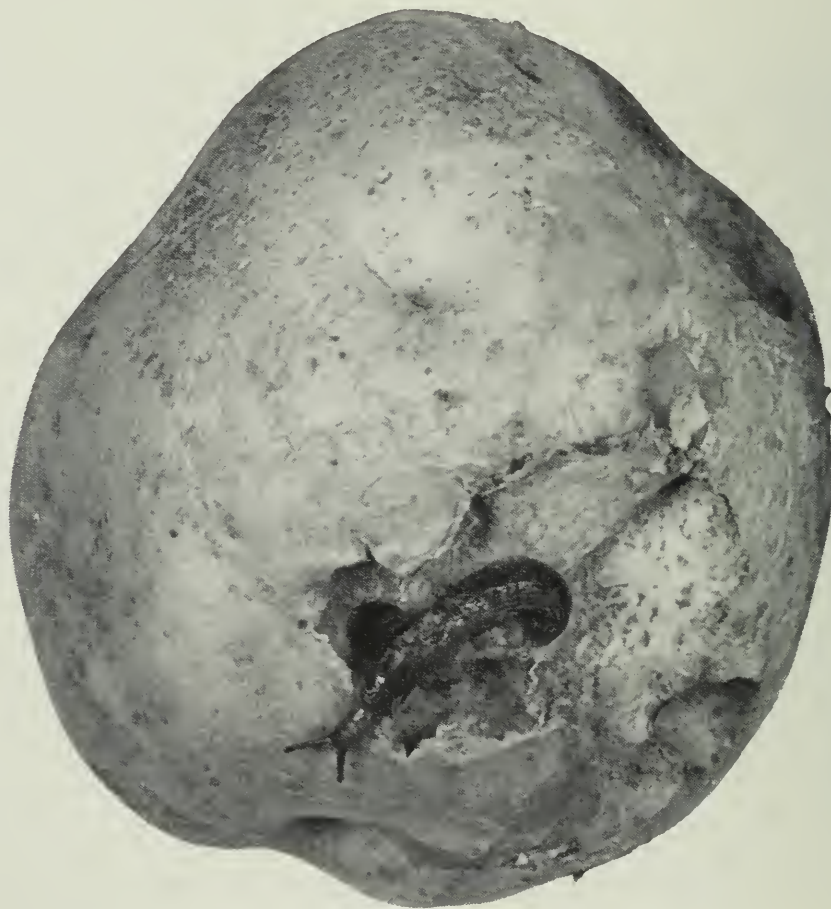


Fig. 7. Grey garden slug and its injury on potato.

Injury

Slugs are nocturnal in habit and feed on many plants. Seedlings may be destroyed. They feed on the lower leaves of cabbage, cauliflower, and lettuce, but the primary objection is that they may remain in the base of the heads through the day and be present in the harvested crop. They eat holes in bean pods, almost cutting across the pods, and in potato tubers, and cause small pit-like holes in turnips and radishes. They feed on the leaves of many plants, usually eating all but the veins.

Life History

Slugs move and feed at night. They spend the winter in the soil. Eggs are laid in masses in damp places in the soil, under boards, or in plant debris. They prefer partly shaded areas. The eggs hatch in about a month to young which look like the adults. These develop slowly and may live a year. Although they may not appear above the ground or feed during drought periods or when it is cold, they are able to withstand these conditions and may cause injury again as soon as moist, warm conditions return.

Control

Slug control in Ontario has been very difficult. Metaldehyde slug-baits kill slugs readily but do not give economic control, except possibly in small home gardens. The methods listed below are helpful.

1. Remove boards, boxes, sacks, and other hiding places from the garden.

2. Obtain a fine seedbed in the spring because slugs find better places for development in lumpy soil.

3. Metaldehyde-bran bait. Metaldehyde attracts slugs to it and is very toxic to them. Several companies sell a prepared bait to place in the garden in small piles or to scatter on the soil according to directions given on the label. Repeat applications several times. Most of these baits are packaged in cardboard similar to breakfast-cereal boxes. These proprietary baits are excellent for home gardens but are likely to be too expensive for field use.

The formula for the bait is not given because metaldehyde, except in prepared baits, is not available to the public in Ontario.

4. Copper-lime dusts. Copper in any form is toxic to slugs. A satisfactory dust may be made by mixing one part by volume of dehydrated copper sulphate with ten parts of hydrated lime. Best results will be obtained if the dust is applied late in the evening on warm, moist nights, but not when it is likely to rain. Use 40 to 60 pounds per acre (one pound to 200 to 300 feet of row). Copper-lime dusts may be satisfactory for field treatment as well as for gardens.

For further information obtain publication 85, "Slug Control in Canada" from Information Service, Canada Department of Agriculture, Ottawa, Ontario.

NEMATODES

Nematodes are very minute pests that belong to a group known as the eelworms, or roundworms. Most of the stages of nematodes are so small that they are invisible to the naked eye. The root-knot nematode may be detected by the knot-like structures it causes on the roots of the host plant.

Plants Attacked

Many vegetable crops may be attacked, depending on the species of nematode. Carrots, tomatoes, celery, and cucumbers are more commonly injured.

Injury

Plants that have been attacked become weakened and sickly in appearance without other visible injury above ground. Roots infested with some species of nematodes show numerous knots or galls on them (Fig. 8). Sometimes nematode infestations will result in a progressive decline in yield from one year to the next and can cause complete loss of crop.



Fig. 8. Carrots infested with and stunted by the root-knot nematode.

Life History

Either the adults or larvae winter in the root galls or in the soil. After mating, each female lays several hundred eggs. The minute worms that hatch may work through the soil and enter new tender roots, where they start new galls. A life cycle may be completed in as short a time as one month.

Control

Control outside is difficult and costly, thus only general suggestions are given here.

1. Rotate crops as much as possible.
2. To prevent transplants from becoming infested inside and carrying nematodes to the field, steam sterilize or fumigate greenhouse or plant-bed soil before planting.
3. If plants, such as tomatoes, for transplanting are purchased, be sure they are free from nematodes.
4. Fumigate infested soil before planting if the crop is valuable enough to warrant the expense.

MILLIPEDES

Millipedes, like slugs, are more common in the home garden than in the field. They generally are not important in vegetable production. Often they are mistaken for wireworms.

Millipedes are greyish to dark brown, wormlike, and about one inch long, and have two pairs of legs on each segment. The outer body covering is hard, and they curl up when disturbed (Fig. 9).

Plants Attacked

Millipedes feed mostly on decaying organic matter. They attack seedlings of many plants or feed in the manner indicated below.



Fig. 9. Millipedes.

Injury

In the greenhouse they chew young shoots of plants or they may destroy seedlings. This type of injury is less common outside. They are found in injuries in roots and tubers on the mature crop, but usually millipedes are secondary, although they may increase the damage. At times they attack healthy roots and tubers. Because they feed in injuries caused by other pests or conditions, often they are blamed for more than they do.

Life History

Millipedes develop throughout the year in greenhouses. Outside, they apparently winter as adults. Eggs are laid in or on the soil in clusters of 20 to 100 or more. These hatch in about three weeks to young which differ from the adults only in size. They develop slowly, with probably one generation a year.

Control

1. Remove boards, piles of decaying plant material, or other objects from the garden as millipedes develop in or under them.
2. If chemical control is necessary, apply 5 per cent DDT dust or spray with DDT.

SOWBUGS

Several introduced species of sowbugs are found in gardens and greenhouses. Occasionally there may be a few in the field. They rarely attack plants outside but may injure seedlings in the greenhouse. Because they are sometimes found in injured or decaying vegetables, they are occasionally blamed for the damage.

Sowbugs are light grey to slate-coloured, oval, flattened forms with seven pairs of legs and up to half an inch long.

Plants Attacked

Sowbugs feed mostly on organic matter. They attack seedlings and young plants.

Injury

The injury is mostly to seedlings in the greenhouse. They may attack plants outside just as they come up.

Life History

Sowbugs develop throughout the year in greenhouses. Outside they develop in decaying material and under debris, boards, and decaying wood.

Control

It is seldom necessary to apply control outside. In the greenhouse, dust places where they are present with 5 per cent DDT. The same control is satisfactory outside.

EUROPEAN EARWIG

Forficula auricularia L.

The European earwig was first reported in Ontario in an area in Grey county in 1938. Areas with infestations by 1956 that are heavily enough infested to cause damage include an extension of the Grey county area to part of Bruce and Wellington counties, and Galt, Fergus, and Toronto. It is likely that this pest will continue to spread in the Province.

The adult is a reddish-brown, beetle-like insect, up to four-fifths of an inch long, with a pair of forcep-like structures at the tip of the abdomen. The wings are short (Fig. 10). The young resembles the adult.

Plants Attacked

The European earwig lives mostly on decaying matter. It may feed on carrot, corn, bean, and lettuce.

Injury

These pests are more important as a nuisance when they crawl into houses than they are outside. However, they eat many garden plants, particularly young seedlings. Carrots, corn, and beans are often injured.



Fig. 10. European earwigs, male on left, female on right.

Life History

Although they are a pest in houses, they develop outside, spending the winter as adults in the ground. Eggs are laid in a cluster or "nest" in the ground in early summer. These hatch to young, or nymphs, that resemble the adults. They become adults after four moults. There is probably only one generation a year in Ontario.

Control

For best control carry out a community baiting program about July 1. A satisfactory poison-bait formula is 24 pounds of bran, 12 ounces of sodium fluoride, 2 quarts of molasses, and about 6 quarts of water. Mix and spread in the manner described for the control of Cutworms on page 13.

Dusts and sprays are also satisfactory. Use 5 per cent DDT or 5 per cent chlordane dust. Apply it particularly to places where the earwig hides during the day. DDT or chlordane may also be applied as sprays.

ASPARAGUS

ASPARAGUS BEETLE

Crioceris asparagi (L.)

The asparagus beetle is one of the most important insects of asparagus, although its numbers and importance vary greatly from year to year. It is widely distributed in Ontario.

The adult is about one-quarter of an inch long and bluish-black; the thorax is reddish with wing covers of dark blue bordered with an irregular area of yellowish orange. The asparagus beetle and the spotted asparagus beetle are shown in Plate C, page 57. The larva of the asparagus beetle is dark and slug-like and is found on the foliage.

Plants Attacked

Asparagus only.

Injury

During the cutting season, the beetles chew holes in the young shoots on which they lay dark-coloured, conspicuous eggs (Fig. 11). Processors, in particular, object to eggs on the shoots because they are very difficult to dislodge and can be removed only by scraping. The beetles also feed on young seedlings in freshly planted beds. After the cutting season, both the beetles and larvae feed on the foliage and, if not controlled, may defoliate the planting.

Life History

The asparagus beetles spend the winter as adults in sheltered places. In the spring they emerge about the time asparagus shoots appear. Feeding, mating, and egg-laying commence a few days later. They lay dark brown, elongate eggs, usually in rows on the shoots (Fig. 11). Later they lay eggs on the leaves and branches. The eggs hatch in about a week; the larvae feed for ten days to two weeks, drop to the ground, and enter the soil, where they spend one to two weeks as pupae. Adults emerge and start a new generation. There are two or three broods a year.

Control

1. Cultivate and fertilize according to horticultural recommendations; this encourages rapid growth during the cutting season and leaves less time for the beetle to feed and lay eggs between the appearance of the shoots and time of harvest.

2. If practical, grow asparagus a distance from places suitable for hibernation of the beetle.

3. Spread powdered Cyanamid along the rows at 100 pounds per acre during the cutting season to kill or repel the beetle.

4. Sprays and dusts.

(a) If the beetle appears during the cutting season, spray with 5 per cent rotenone powder 5 pounds plus a spreader in 100 gallons of water or dust with 1 per cent rotenone at 30 to 40 pounds per acre. Or, provided you do not harvest until three days after application, spray with 40 per cent TEPP liquid $\frac{1}{3}$ pint in 100 gallons of water.

(b) After harvest and on young plantings not being cut, spray with 50 per cent DDT wettable powder 2 pounds, lead arsenate 4 pounds, or 15 per cent parathion wettable powder $1\frac{1}{2}$ pounds, in 100 gallons of water; or dust with 5 per cent DDT at 30 to 40 pounds per acre or with a ready-prepared arsenic dust.



Fig. 11. Left: eggs of the asparagus beetle on shoot; right: feeding injury typical of either species of beetle.

SPOTTED ASPARAGUS BEETLE

Crioceris duodecimpunctata (L.)

The adult of this beetle is reddish-orange with twelve black spots on the wing covers. It resembles a lady beetle in colour but differs from it in that the thorax is narrower than the wing covers, Plate C, page 57.

Plants Attacked

Asparagus only.

Injury

The adults feed in the same manner as the asparagus beetles. They do not cause so much injury because the eggs are laid later in the season and the larvae do not feed on the foliage.

Life History

The spotted asparagus beetles appear later and develop in a similar manner to the asparagus beetles, except that the eggs are laid on the leaves and, upon hatching, the larvae crawl to, and develop in, the berries. One larva may eat the pulp and seeds of several berries. There are usually two generations a year.

Control

Apply the same control as described previously for the asparagus beetle.

BEANS

SEED-CORN MAGGOT

Hylemya cilicrura (Rond.)

The seed-corn maggot is one of the most important pests that attack newly planted seed. It works in combination with bacteria and fungi that cause seed decay. Although the common name implies that it is more destructive on corn, there has been more damage to beans in Ontario. The seed-corn maggot is more injurious in cold, wet springs when germination is slow. Severely damaged crops require reseedling.

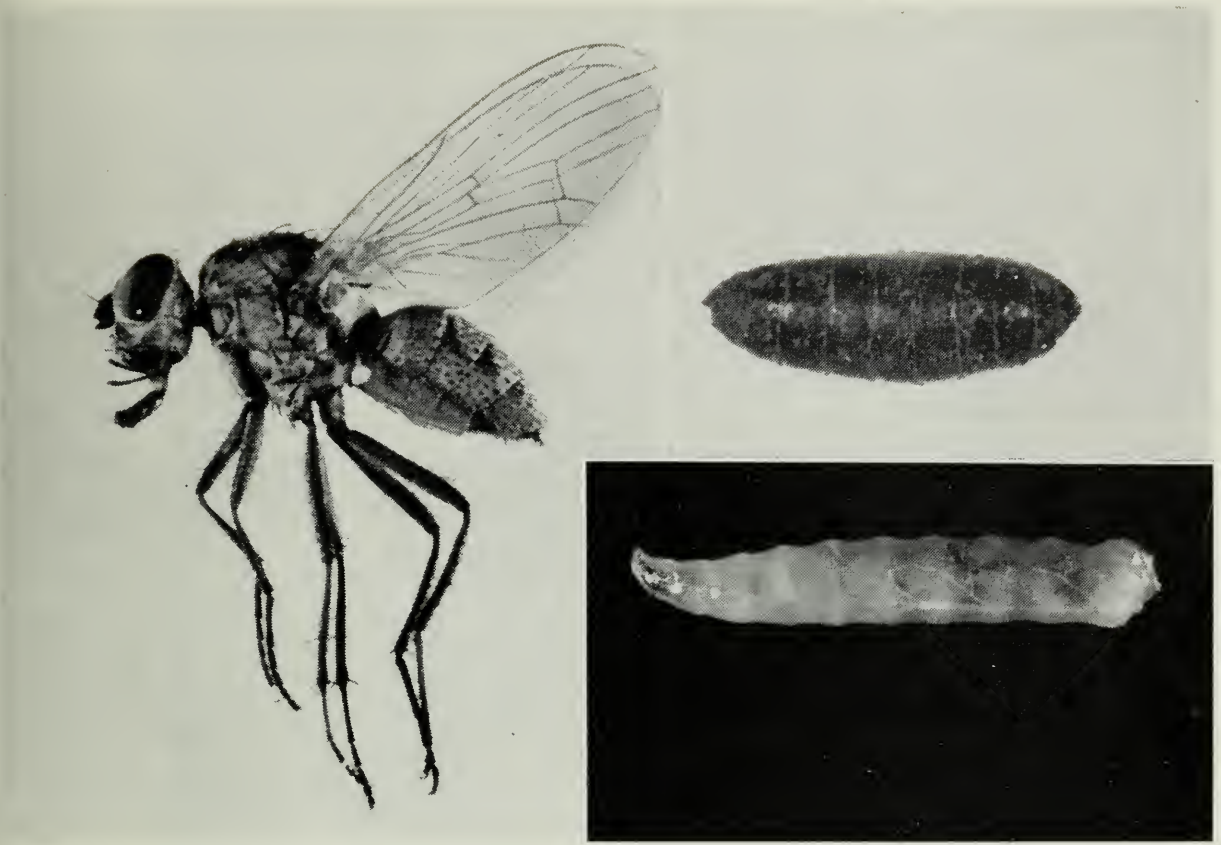


Fig. 12. Seed-corn maggot. Left: adult; upper right: pupa; lower right: larva.

The adult is a greyish fly, slightly smaller but with longer legs than a house fly. The maggot, the injurious stage, is smaller than, but similar in shape and colour to, a house-fly maggot, being creamy-white, tapered to the front end, and without head or legs. It is usually found in the seed in the ground. It will not attack unplanted seed. Infestations in the field do not originate with the seed. The adult, larva, and pupa are illustrated in Figure 12.

Plants Attacked

The seed-corn maggot attacks most severely large-seeded crops such as beans, corn, cucumber, and squash. Occasionally peas are injured. Seed potatoes, cabbage, and radish are less commonly attacked.

Injury

Seeds attacked either do not come up or come up as "bald-heads" (Fig. 13) owing to the maggots destroying the leaves between the cotyledons. An examination of seed that fails to come up will likely reveal the maggots in the decaying seed where maggots and seed-decay organisms have worked together. The injury to peas by the seed-corn maggots is shown in Figure 14.

Life History

In southwestern Ontario, there are one to four generations a year, with probably one in the northern areas. The winter is spent in the soil in the pupal stage. The adult flies emerge toward the end of April in the southern areas and about the middle of May farther north. Their tiny, white eggs are laid in the soil near decaying organic matter or germinating seeds. The eggs hatch in about three days and the maggots feed on decaying organic matter or seeds. In the southern areas, the maggots are full-grown in about three weeks. They pupate in the soil, and the flies emerge the end of May or in early June. A new generation of flies appears about the end of June. The first and second broods attack early corn, peas, soybeans, white, lima, and kidney beans, tobacco, and late potatoes. The third and fourth broods are usually small and unimportant. The last brood of larvae to develop pupates in the soil and remains there until the following spring.



Fig. 13. Bean plants. Left: normal; centre: injured by seed-corn maggot; right: severely injured to the "bald-head" stage.



Fig. 14. Peas injured by the seed-corn maggot.
Note maggots in seed.

Control

There is no practical control for the seed-corn maggot after injury is noticed. Certain cultural practices help prevent damage. Seed treatment is advisable every year as an insurance against infestation, especially where it is desirable to seed early or before the soil is warm. Use any or all of these methods that are applicable to your cropping practice.

(a) If manure is used, apply well-rotted material and plough it under the fall before.

(b) Plant susceptible crops on well-drained, well-prepared, warm soil, particularly if the crop is sown early in the season.

(c) Sow the seed as shallowly as possible.

(d) If the seed is destroyed to the extent that too thin a stand will result, re-seed at once.

(e) Seed Treatment. Protection of the seed from the seed-corn maggot will be obtained if an insecticide and a fungicide are applied to the seed before planting. Since the seed-corn maggot works in conjunction with seed-decay organisms, the fungicide is also required; otherwise, the maggot will gain entrance, even though a poison is on the seed coat. The following insecticides have been recommended up to 1956: lindane, aldrin, dieldrin, or heptachlor at the rate of $\frac{1}{2}$ ounce of 50 per cent wettable powder, along with $1\frac{1}{3}$ ounces of 75 per cent thiram or $1\frac{1}{3}$ ounces of 75 per cent captan as the fungicide, per bushel of seed. Mix the correct amount of insecticide with the thiram or captan. Add $\frac{1}{2}$ pint of water for each bushel of seed to be treated and agitate thoroughly. Pour this mixture over the seed and shovel until the lot is uniformly wetted. Large batches may be mixed in a cement mixer or with seed-treating equipment.

Ready-prepared seed dressings that contain both an insecticide and fungicide are available for seed-corn maggot and disease control. Follow manufacturer's directions. Many seed dealers merchandise seed that has been treated for both seed-corn maggot and seed-decay organisms.

MEXICAN BEAN BEETLE

Epilachna varivestis Muls.

The Mexican bean beetle looks like, and belongs to the same family of insects as, the lady beetle. The adult is one-quarter to one-third of an inch long, convex in form, coppery-brown in colour, with eight small black spots on each wing cover that form three rows when the wings are folded. The larva is yellow with six rows of black-tipped spines on its back. They pupate on the leaves. The larva, pupa, and adult are shown in Plate D, page 57.

The Mexican bean beetle was first discovered in Ontario in 1927. Until 1950 it caused little trouble, except occasionally in home gardens. Possibly several severe winters between 1927 and 1950 kept the population low. From 1950 to 1956, damage occurred to beans in both field and garden in southwestern Ontario. Beans in home gardens have also been attacked along the north shore of Lake Ontario.

Plants Attacked

This beetle has been most injurious to garden and field beans, including lima beans and especially red kidney beans, in Ontario. Cowpeas and soybeans are attacked. When this insect is very numerous, it may attack alfalfa, clover, vetch, and grasses in addition to beggar-tick and some weeds.

Injury

Both the adults and larvae feed on the lower surface of the leaves, where they eat partly through it. The area above the feeding dies, and later the upper leaf surface breaks, leaving a skeletonized appearance. In the very heavy attack the leaves and stems may be eaten to such an extent that the plant dies.

Life History

These insects spend the winter as adults on the ground in grass, leaves, or rubbish, especially in Woodland and hedgerows near the fields where beans were grown the previous summer. The beetles leave winter quarters over an extended period of time, with the earlier ones arriving in the new bean fields when the beans first come up. Others find their way to the garden and fields later. The beetles feed for one to two weeks and then deposit orange-yellow eggs in groups of 40 to 50 on the undersides of the leaves. The eggs hatch in five to fourteen days; the larvae feed for two to five weeks and then change to pupae which are fastened to the leaves. The pupal period is about ten days. There may be a second generation in the season.

Control

Generally speaking, this insect is difficult to kill with insecticides. Control will be better if materials are applied when the larva is small. As dusts, use 1 per cent rotenone or 1 per cent freshly prepared TEPP. Or you may use rotenone or TEPP sprays. Parathion and malathion sprays or dusts have also been used for this pest. In home gardens use rotenone, malathion, or home-garden vegetable insect dusts or sprays. Rate for application will be given on the manufacturer's label.

LEAFHOPPERS

Several species of leafhoppers attack beans and may, at times, cause considerable damage. The potato leafhopper, *Empoasca fabae* (Harr.), is one of the most common. It is described on page 101.

Injury

The nymphs and adults suck the juice from the undersides of the leaves. This causes the leaves to be stunted and crinkled and to roll upwards and inwards. Yields may be reduced as a result of the leaf injury. During some seasons leafhoppers may be the most serious insects of beans.

Life History

The potato leafhopper is described on page 101 in the potato insect section. Other leafhoppers that attack beans have a fairly similar development.

Control

Many of the insecticides will control leafhoppers. Because it has a long residual action, DDT is recommended, but only if there are heavy enough populations, such as three adults or nymphs per plant, to warrant spraying or dusting. Since DDT may cause some injury on young beans, wait until the eight-leaf stage before treatment, unless the infestation is severe. Dust with 3 per cent DDT at 30 to 35 pounds per acre (5 per cent at 15 to 20 pounds per acre) or spray with 50 per cent DDT wettable powder 2 pounds in 100 gallons of water. After pods form on snap beans, use only rotenone dusts or sprays. Materials such as malathion may be used on snap beans after pods form, provided that the number of days required between treating and picking are maintained. These times are given on the manufacturer's label.

BEAN WEEVIL

Acanthoscelides obtectus (Say)

The bean weevil is a small, stout, somewhat wedge-shaped, yellowish-brown or olive-coloured beetle about one-eighth of an inch long and one-tenth of an inch wide.

This weevil is mainly a pest of stored beans in Ontario and thus is usually not of great importance to the bean grower.

Plants Attacked

The bean weevil attacks beans and peas in storage, especially white and kidney beans. Outside, usually only beans are attacked.

Injury

(a) To the seed—The weevils develop in the seed in storage. Heavily infested seed will be riddled with holes (Fig. 15). If these weevils are allowed to continue developing in stored beans, they will reduce them almost to powder.

(b) To the growing crop—The growing crop is not commonly attacked in Ontario. Beans grown in the home garden are more likely to become infested during the growing season. When this happens, the weevils develop in the seed inside the pod.

Life History

The adult beetles lay their eggs on the seed in storage. The larvae on hatching bore into the seed and feed there until maturity. Each larva, or grub, makes a separate chamber for itself, and a single bean may contain a dozen or more chambers. The larvae develop here and change



Fig. 15. Beans injured by bean weevils.

to pupae, and the adults cut the seed coat to emerge, leaving holes in the seed. They continue to develop in storage with six to eight generations a year occurring if the storage temperature is high.

When these weevils attack the growing plant, the females chew small areas in the pod in which they lay their eggs. Upon hatching, the larvae bore to the seeds in the pod, where they develop to adults. The entrance holes in the pods heal over, leaving only small, brown spots on the outside. Thus, infestations are often not known until harvest.

Low winter temperatures kill bean weevils that spend the winter outside. This is why they seldom are injurious to beans in the field or garden in this province.

Control

1. Do not plant weevil-infested seed because they may contain live weevils and thus start an outside infestation.
2. Store bean seed, if possible, at outside temperatures. Never store beans where the temperature is high.
3. If lightly infested seed is to be sown, make sure there are no live weevils in it by subjecting the seed to zero temperatures or fumigating it. Follow the directions for fumigation given on Departments of Agriculture stored-grain insect outlines or use a grain fumigant according to manufacturer's directions.

TWO-SPOTTED SPIDER MITE

Tetranychus telarius (L.)

The two-spotted spider mite is so small that the adult can scarcely be seen with the naked eye. It varies somewhat in colour, being either pale or reddish, and usually it has two indistinct spots from which it gets its name (Fig. 16). Sometimes the spots are quite distinct, other times they are not conspicuous. Unlike an insect, it has eight legs, except in the early stages.

This mite has become more important and injurious since some of the new insecticides have been in general use. Some of the increase in abundance may be the result of greater winter survival from 1948 to 1956 because during this period there was not the low temperature to equal that of 1947 and 1948.

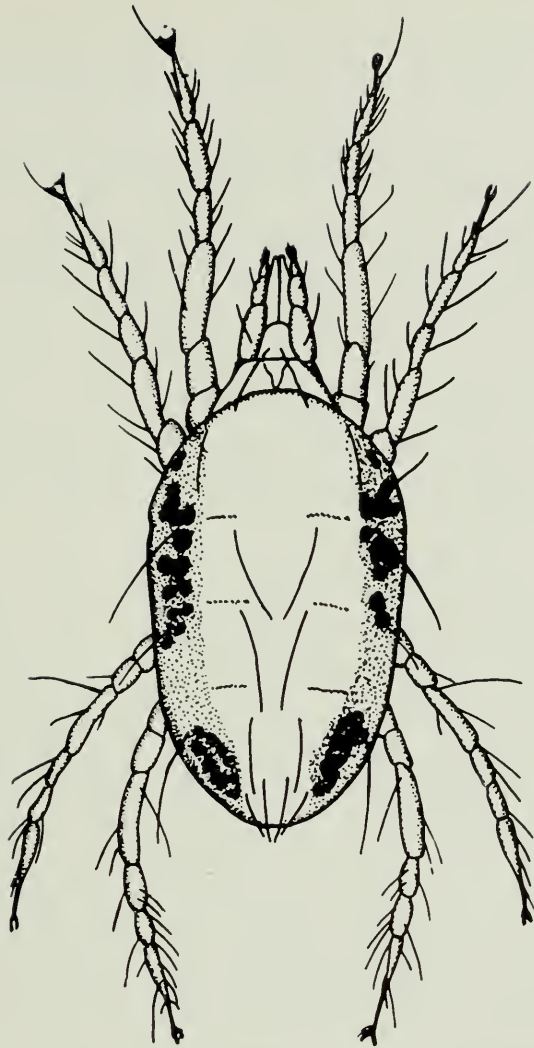


Fig. 16. Two-spotted spider mite, greatly enlarged.

Plant Attacked

Beans are a very susceptible vegetable crop to the two-spotted spider mite. This mite attacks cucumber, tomato, corn, apple, peach, and strawberry, in addition to many flowers, field crops, shrubs, and especially greenhouse and house plants. There are many weed hosts.

Injury

Both the adults and nymphs suck the sap from the leaves, causing them to become pale and sickly with a white speckled appearance. Later, the leaves may curl, become brown, and drop. Besides the loss of sap from feeding, they may inject a poison into the plant. Injury is often severe during hot dry weather.

Life History

The two-spotted spider mites spend the winter as adults on plant debris or in any hiding place near their host plants. In the spring they

feed on any cultivated or weed host that is near. Many generations develop during the summer. The mites spin webbing under the leaves in a heavy attack, and the eggs may be suspended in it. The young and adults move back and forward in the webbing and feed on the plant sap. The two-spotted spider mites have the potential to develop to extreme numbers in a short time if conditions are suitable for increase.

Control

Natural control factors are very important in controlling it. These include the presence of parasites, predators, and other conditions unsuitable for mite development. Thus, resort to sprays and dusts only when necessary.

DDT and many of the insecticides related to it will not control this mite; in fact, increases in mite numbers often occur where these materials are used. Where DDT and similar materials are required for other pests, it may be advisable to add a miticide to them to prevent mite build-up.

Where direct sprays are required, use 15 per cent Aramite wettable powder $1\frac{1}{2}$ pounds in 100 gallons of water. Or you may use one of the organic phosphate sprays, such as malathion, parathion, or TEPP. Follow manufacturer's directions concerning the safe handling of these chemicals.

There are many other insecticides that have been, or are being, tested. Some of these are not readily available at present. Therefore, consult the current season's vegetable-insect recommendations prepared by the Departments of Agriculture for up-to-date information.

OTHER INSECTS of BEANS

Aphids

Several species of aphids attack beans but generally are not of great importance in Ontario. A black species known as the bean aphid, *Aphis fabae* Scop., occurs occasionally on lima beans. The melon aphid, *Aphis gossypii* Glov., and the pea aphid, *Macrosiphum pisi* (Harr.), sometimes are present on beans. If aphids are numerous enough to warrant control measures, use the methods given under Aphids on page 11.

Cutworms, Wireworms, Grasshoppers, Slugs

These pests will attack beans, although they may not be so important on this crop as some others. Slugs eat the foliage and also eat holes in the pods of snap beans.

Corn Borer

Occasionally the corn borer may be found in the stems of the plants.

Pea Weevil, Pea Moth, Spotted Cucumber Beetle, Green Cloverworm

These pests attack beans but are not so injurious on this crop as other insects are. Control is rarely required for the green cloverworm. Descriptions of and control for the others are given in the sections on pea and cucumber in this bulletin.

BEET

Red beets are not attacked by so many destructive pests as other crops. As a result, only rarely are insecticide treatments required.

Spinach Leaf Miner

This pest attacks the leaves of beets and also spinach. However, since the leaves are only occasionally eaten, it is not very important on this crop. A description of and treatment for the spinach leaf miner is given on page 106.

Cutworms, White Grubs, Wireworms

Cutworms, white grubs, and wireworms may attack the roots, with cutworms often being the most injurious of these three.

Flea Beetles

Flea beetles may injure the foliage, but once the plants are established the injury is not likely to be important. If flea beetles attack, dust or spray with DDT in the same way as recommended for the potato flea beetle.

CABBAGE, CAULIFLOWER, RADISH, TURNIP, and RELATED CROPS

CABBAGE MAGGOT

Hylemya brassicae (Bouché)

The cabbage maggot is probably the most serious insect on these crops, particularly on cabbage, cauliflower, radish, and turnip. This pest is important in all parts of Ontario where these crops are grown.

The adult is a two-winged fly, nearly as large as the house fly but with longer legs, and very similar in appearance to the seed-corn maggot fly (Fig. 12). The larva is a white maggot with neither legs nor head and is pointed at the anterior end similarly to the seed-corn maggot (Fig. 12).

Plants Attacked

Cabbage and cauliflower are very subject to attack, the damage being more severe on cauliflower. The cabbage maggot is also very injurious to radish, turnip (rutabaga), and table turnip. Brussels sprouts, broccoli, kohlrabi, and chinese cabbage may be injured. Many of the weeds of the mustard family, Cruciferae, are hosts. The maggot has been reported to attack some other vegetables, such as beets, that are not family Cruciferae.

Injury

The maggots attack the roots of cabbage and related plants (Fig. 17). With cabbage, cauliflower, brussels sprouts, broccoli, kohlrabi, and chinese cabbage, they feed on the roots; thus, the plants either are weakened and produce small yields or may be killed. When the plants are killed, they remain in place in the soil, unlike plants that are cut off at ground level by cutworms. With radish and turnip, the maggots often kill seedling plants, but by far the most important injury is to the edible part (Fig. 18). On turnips the injured area is usually not deep, but turnips may be out of grade as a result of the injury.

Life History

This insect has four stages in its cycle—eggs, larvae (maggots), pupae, and adults. They spend the winter as pupae in the soil close to the old roots where they developed in the previous summer. The adult flies emerge at varying times in different areas of the Province and begin to lay their eggs usually about the time of full bloom of wild plums, although it is sometimes slightly earlier than this in southwestern Ontario. In eastern Ontario this is about May 12 in an average year. The flies lay eggs against the stems of the plants or in nearby cracks in the soil. These hatch in about five days and the maggots immediately work into the root area, where they feed by rasping the plant tissue with two black hook-

like structures that are used as mouthparts. When mature, the maggots pupate in the soil near the roots (see pupa in Fig. 17). There are at least two and sometimes three broods a year, with four occurring some years in the most southern areas of Ontario.

Control

Cabbage and cauliflower

Since early cabbage and cauliflower are almost always attacked, treat them every year with an insecticide either before planting, at planting time, or after planting. Since late-planted cabbage are not usually injured to any extent, provided the seed bed was treated, a grower may wish to save the cost of time and materials by not treating in the field; if, on occasion, the pest is very prevalent and kills some of the plants, he can replant.

Because there are three satisfactory times for treatment to control the cabbage maggot—that is, before planting, at planting, or after planting—as well as four or more different insecticides with four formulations of each of these, details of rates of material have not been included. These will be given each year in the current Ontario Protection Calendar for Vegetables. Follow instructions carefully, especially concerning the use of insecticides in the transplant water, because an overdose will injure or kill the plants.

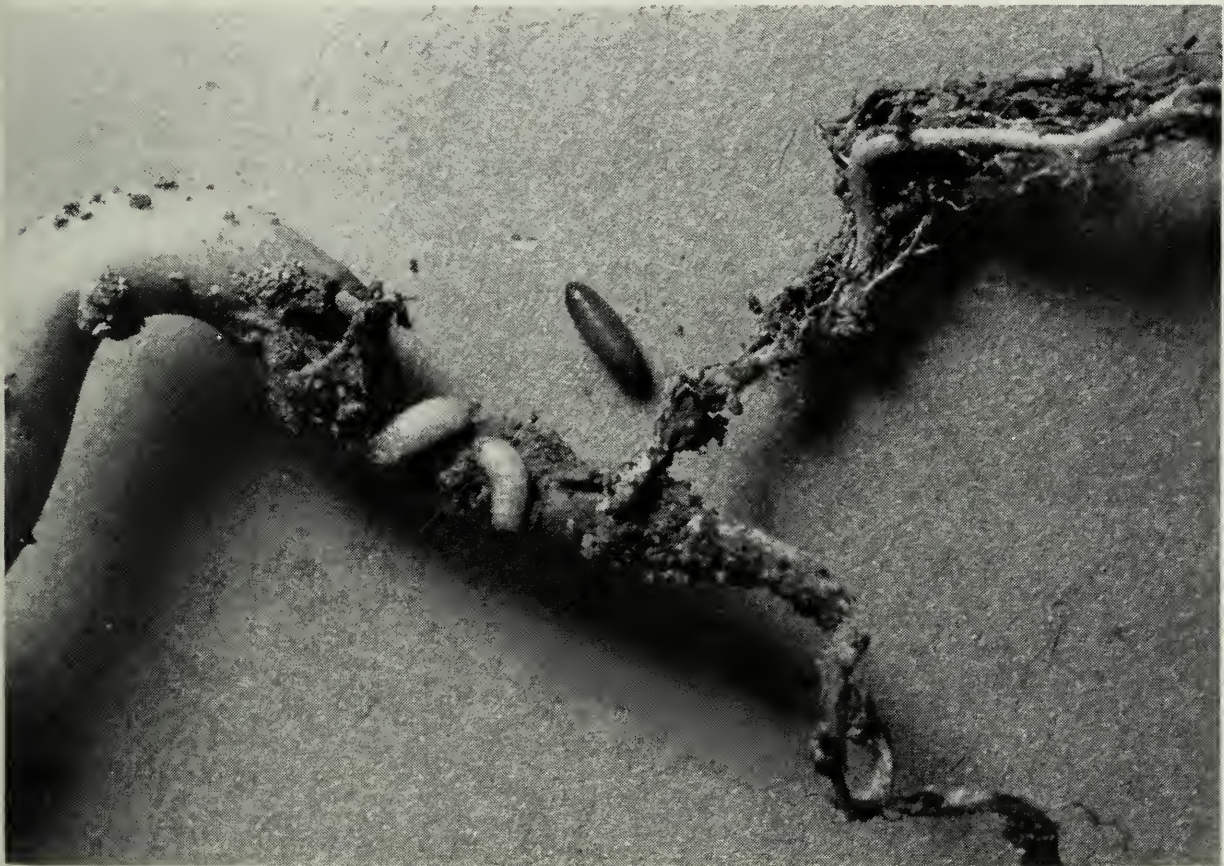


Fig. 17. Cabbage root severely injured by the cabbage maggot.
Two larvae and a pupa are shown.

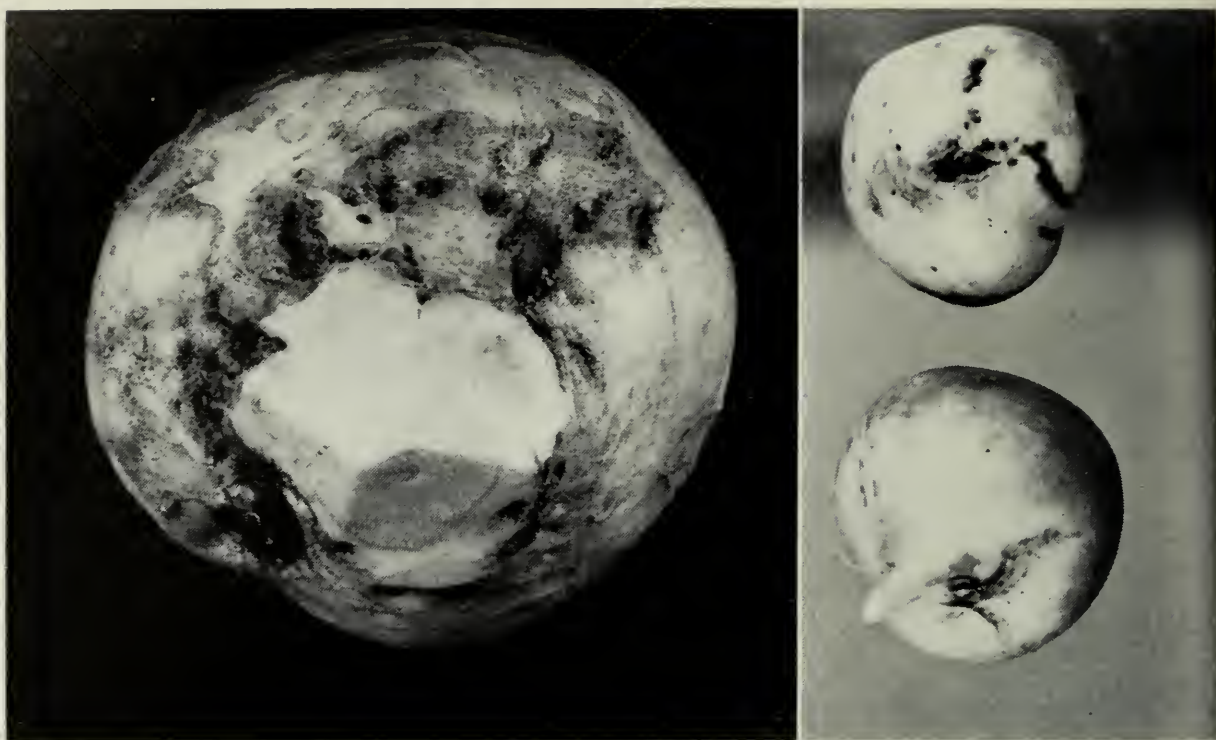


Fig. 18. Turnip and radishes showing cabbage maggot injury.

The following are three methods outlined without detail concerning rates.

(a) Before-planting treatment

Apply aldrin, chlordane, dieldrin, or heptachlor to the soil before planting. Spray the insecticide on, or apply it as a dust or granulated form and work into the top two or three inches of soil before planting. Be sure seed beds are treated before sowing the seed.

(b) Planting treatment

Add one of the insecticides given under (a) to the transplant water and apply the recommended amount to each seedling hole.

(c) After-planting treatment

This method appears to be the safest from plant injury and to give the most reliable control. However, accurate timing of application is necessary. The insecticides given under (a) may be applied as either dusts or sprays. Apply a dust or spray to the soil surface three or four days after plants have been set in the field. Repeat treatment in ten days. For early cauliflower, especially if the plants are under irrigation and on light soil, repeat at least twice at seven-day intervals.

Mercuric chloride has been used for control of the cabbage maggot for a long time but it appears to be inferior to the preceding newer chemicals.

Radish

Apply aldrin, chlordane, dieldrin, or heptachlor to the soil before planting, as described under cabbage and cauliflower.

Turnip

The cabbage maggot is very difficult to control on the Swede turnip (rutabaga), possibly because of the very long growing season for this crop. Before-planting and after-planting treatments with aldrin, chlordane, dieldrin, and heptachlor have been used in Ontario with variable results depending on the season, severity of maggot attack, and other factors. Follow the directions for these and other methods that are in each year's "Turnip Protection Guide".

STRIPED FLEA BEETLE

Phyllotreta striolata (F.)

The striped flea beetle and related species are injurious to plants of the cabbage family, especially when these plants are small. These insects are present throughout Ontario and are well known to the turnip grower as some of the most important pests of turnips.

The adult is a small black beetle about one-twelfth of an inch long with a wavy, inconspicuous, yellow stripe lengthwise of each wing cover. The hind legs are developed for jumping, thus the common name flea beetle. The larva is a yellowish-white grub that is rarely seen since it develops in the soil.

Plants Attacked

The striped flea beetle and related species attack all plants of the mustard family, including particularly the cultivated group such as cabbage, turnip, and radish.

Injury

The adults eat small shot-like holes in the leaves, especially just as the plants break through the soil, killing the plants if feeding is severe.

Turnip plantings may be completely destroyed just after the plants emerge. This insect also attacks other plants. Cabbage and cauliflower may be injured in the seed bed.

The larvae feed on the roots. The injury by the larvae is not important except on turnips (rutabagas), where it is suspected that the pitted-type injury occasionally found at harvest is caused by the flea beetles and related species.

Life History

They winter as adult beetles in or near where they developed the year before, in any shelter such as plant debris, grass, and leaves. They leave their winter quarters during the first warm days and feed on any host plants available, these often being weed hosts. After a short feeding period, they mate and lay their eggs near the host plants, the females penetrating into the soil up to three-quarters of an inch to deposit eggs. The larvae, which are white with dark heads, feed mainly on the fine roots. It is suspected that they occasionally feed on the main root of the turnip, causing little pits in the skin. The larval period takes three to four weeks, which is followed by a pupal period in the soil of about two weeks. The new generation of beetles appears in August. Generally there is one generation a year, although it is possible that a few produce a second brood.

Control

1. Control weeds of the mustard family, such as mustard, peppergrass, and shepherd's purse, throughout the season because these are hosts for the striped flea beetle.
2. Plough under plant remnants or work them into the soil in the fall. This will reduce the overwintering places for the beetles.
3. If the beetles attack, dust with 5 per cent DDT at 25 to 30 pounds per acre, or spray with 50 per cent DDT wettable powder 2 to 3 pounds, or 25 per cent DDT emulsion 2 quarts, in 100 gallons of water. The sprays and dusts recommended in this bulletin for the cabbage maggot on turnips will also control the flea beetles and are recommended where control of both flea beetles and the cabbage maggot is desired at the same time.
4. Turnips sown after June 20 are not so likely to be attacked. If at any time turnip seedlings are destroyed, reseed at once.

CABBAGE APHID

Brevicoryne brassicae (L.)

TURNIP APHID

Rhopalosiphum pseudobrassicae (Davis)

Although other species of aphids may be present on crucifers, cabbage and turnip aphids only are important in Ontario. Outbreaks of these are sporadic, with severe injury often being caused by both species during an attack.

These two aphids are similar in appearance except that the cabbage aphid is covered with a powder that gives it a greyish-white appearance (Fig. 19) whereas the turnip aphid is green.

Plants Attacked

They attack all plants of the mustard family.

Injury

Aphids suck the juice from the plants and cause them to become sickly and yellow. Turnips may be completely killed by a severe attack. In addition to causing direct injury, aphids contaminate the harvested crop, especially broccoli, sprouts, and cabbage, and transmit virus and other diseases.



Fig. 19. Cabbage aphids.

Life History

The development of both species is generally similar to that described under Aphids on page 11.

Control

Natural control is very important. There are many parasites that attack the aphids in addition to predators such as lady beetles and syrphus flies.

Sprays and dusts. It is difficult to know when to apply direct control. Sprays and dusts are usually more effective before the populations become large; however, natural factors often bring small populations under control. Since aphids, either dead or alive, are particularly objectionable on harvested broccoli, a complete aphid-control program is usually necessary on this crop. It is likely that sprays and dusts will be required almost to harvest time. Insecticides in which the toxic residues disappear quickly, such as TEPP and nicotine, are recommended close to harvest.

Insecticides for aphids and rates of application are given under Aphids on page 11.

CABBAGE CATERPILLARS

Three species of caterpillars commonly attack cabbage and related crops in Ontario, namely, the imported cabbageworm, *Pieris rapae* (L.); the larva of the diamondback moth, *Plutella maculipennis* (Curt.); and the cabbage looper, *Trichoplusia ni* (Hbn.). The zebra caterpillar, *Ceramica picta* (Harr.), is occasionally present in injurious numbers.

Imported Cabbageworm

The imported cabbageworm is a velvety-green caterpillar a little more than an inch long when full grown and almost the same colour as the cabbage leaf. It has a faint golden line down its back (Fig. 21).

The adult is the familiar white butterfly with a small black area at the tip of each front wing, two black dots on each front wing of the female and one on each front wing of the male, plus a single black dot on each hind wing of both sexes.

This insect is the most injurious of the cabbage caterpillars in Ontario. It occurs wherever cole crops are grown.



Fig. 20. Cabbage injured by cabbage caterpillars.

Plants Attacked

The imported cabbageworm feeds on all plants of the cabbage, or mustard, family such as cabbage, cauliflower, kale, kohlrabi, brussels sprouts, turnip, radish, wild mustard, and others. It also feeds on nasturtium, sweet alyssum, and lettuce.

Injury

The caterpillars eat large, irregular-shaped holes in the leaves of cabbage and related plants (Fig. 20). They also eat holes in the heads of cabbage and deposit quantities of dark-green excrement that stains the heads. As well as eating the leaves of cauliflower, they stain the heads with their excrement. Excrement and insect fragments may reduce the quality of broccoli, brussels sprouts, and other crucifers.

Life History

The imported cabbageworms overwinter as chrysalids attached to old cabbage plants (Fig. 21) or to some object in or near where the host plants grew; however, butterflies may also migrate in from warmer areas. They lay their cream- to yellow-coloured eggs singly, mostly on the undersides of the leaves. The eggs hatch in about five days and the caterpillars feed for two or three weeks before changing to the pupal stage. This stage lasts about ten days. There are three or four generations a year in southern Ontario.

Control

Since some caterpillars are present every year, it is advisable to spray or dust before they cause injury. Several insecticides will control them; thus, the choice of an insecticide will depend on other pests that may be present. To avoid poisonous residues, consider also the length of time from treatment to harvest when selecting materials that will be used close to harvest.

Often early cabbage and cauliflower do not require treatment. On early crops where caterpillars are present and on late crops, apply 3 per cent DDT dust at 30 to 40 pounds per acre (5 per cent DDT dust at 20 pounds per acre) or spray with 50 per cent DDT wettable powder 2 pounds in 100 gallons of water. After heads form on cauliflower, or within thirty days of harvest on other crucifers, use 1 per cent rotenone dust or spray with 5 per cent rotenone powder 4 pounds in 100 gallons of water.

Diamondback Moth

The caterpillar of the diamondback moth is light green with a dark brown head. It is smaller than the other species of cabbage caterpillars (Fig. 21) and has the habit, when disturbed, of wriggling and dropping from the leaf on a silken thread.

The adult is a small, greyish-brown moth that is rarely seen. The insect is named from three diamond-shaped, yellow spots formed down the middle of the back when the wings are folded.

Plants Attacked

The diamondback moth attacks all the plants in the cabbage, or mustard, family in addition to some ornamental and greenhouse plants such as sweet alyssum, stocks, and wallflower.

Injury

The larvae feed from the lower leaf surface, chewing smaller holes than the other species. The holes later extend to the upper surface.

Life History

These insects apparently do not overwinter in most parts of Ontario. Infestations begin each spring from moths that migrate from more southern areas. Eggs are laid singly or in small groups, mostly on the upper surface of the leaves of the host plants. Caterpillars hatch from these in a few days and develop to maturity in ten to twenty days. They pupate on the leaves (Fig. 21) and change to adults in one to two weeks. There are four to six generations a year.

Control

Use the same materials recommended for the imported cabbageworm.

Cabbage Looper

This insect is not so plentiful in Ontario as the imported cabbageworm and diamondback moth. However, in outbreak years like 1955, it may cause more damage than the other two species.

The cabbage looper caterpillar is about one and a quarter inches long when mature. It is paler green than the imported cabbageworm with white strips along its back and sides. The most distinctive characteristic is the presence of only two pairs of abdominal prolegs close together

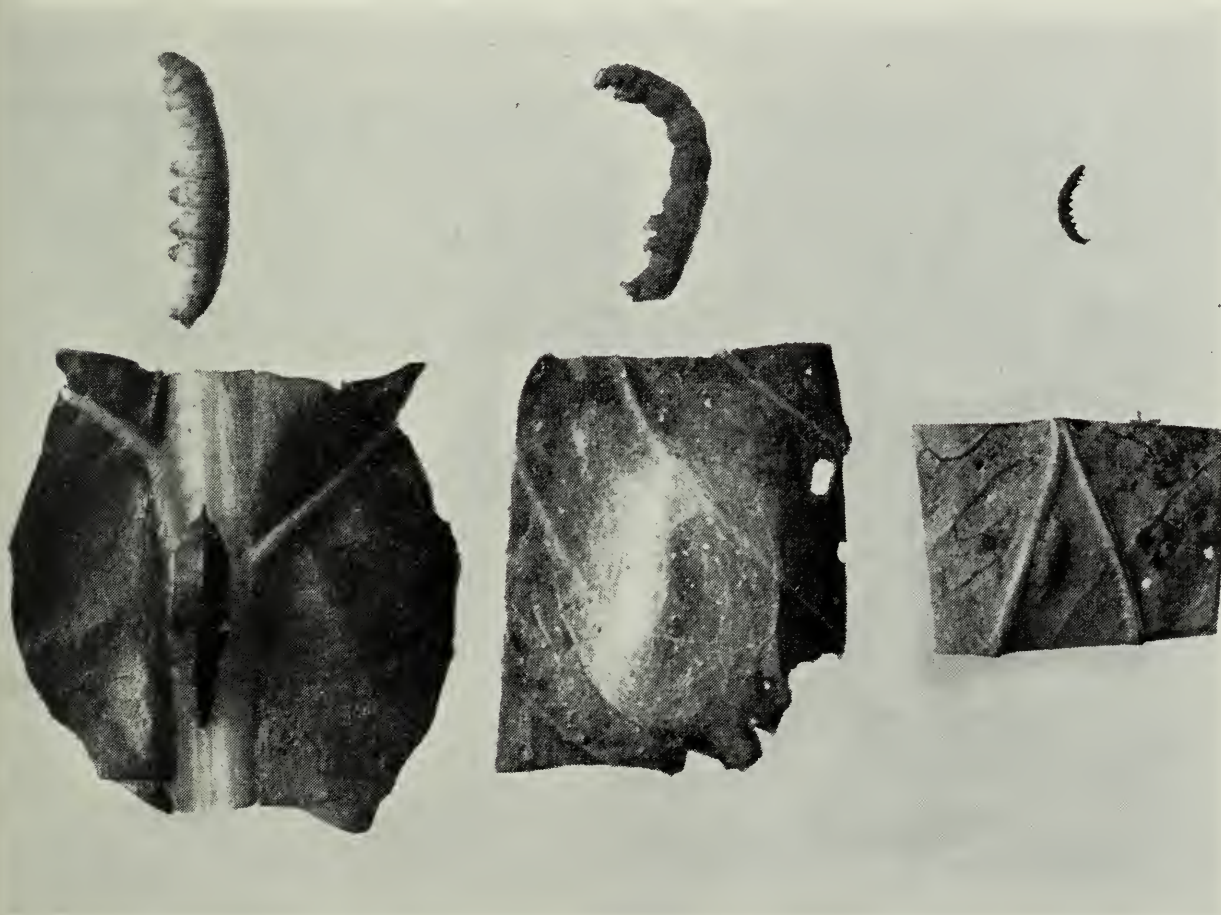


Fig. 21. From left to right: imported cabbageworm and pupa, cabbage looper and pupa, and diamondback and pupa.



Plate A. Winged and wingless aphids.



Plate B. Lady beetle larva.



Plate C. Left: spotted asparagus beetle; right: asparagus beetle.



Plate D. Mexican bean beetle. Upper left: pupa; upper right: larva; lower: two adults.



Plate E. Tarnished plant bug.



Plate F. Brown area on celery caused by tarnished plant bug.

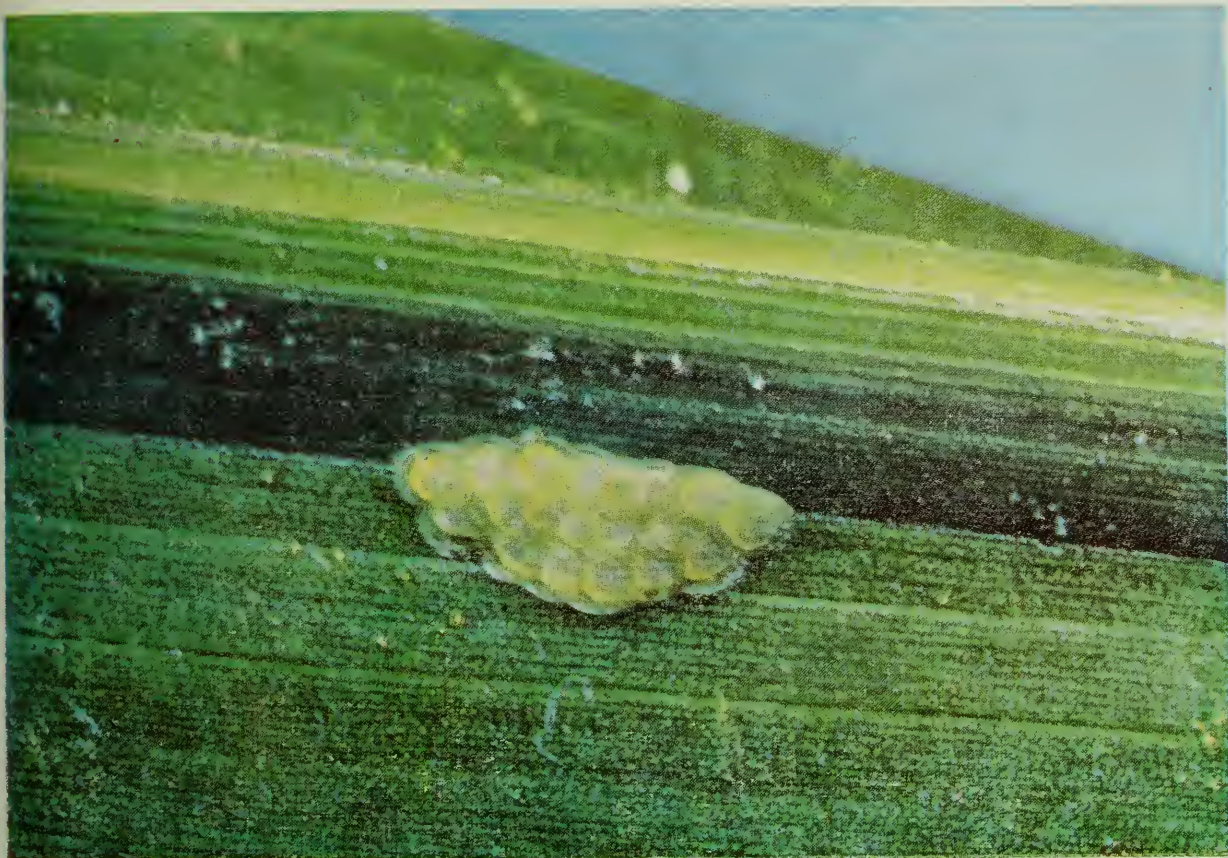


Plate G. Corn borer egg mass on corn leaf.



Plate H. "Pin-hole" feeding on leaf by a young corn borer.



Plate I. Lettuce infected with aster yellows virus.



Plate J. "Hopperburn" at edge of potato leaf caused by potato leafhopper.
Shot-like holes were caused by flea beetles.

on the abdomen compared to four for the other species as shown in Figure 21. It thus moves with a looping fashion, hence the common name.

The adult is a greenish-brown moth with a silvery spot on each front wing. It is nocturnal in habit and rarely seen.

Plants Attacked

The looper attacks all plants of the cabbage, or mustard, family as well as many other plants such as lettuce, spinach, pea, celery, parsley, potato, tomato, nasturtium, and mignonette.

Injury

The cabbage loopers feed on the leaves of cabbage and cauliflower, frequently destroying maturing cabbage heads by boring into them near the base.

Life History

The insects overwinter as pupae. The moths lay eggs in the spring, singly, on either side of the leaves of the host plants. These hatch in four or five days and the loopers mature in two to three weeks. These pupate on the leaves and moths emerge in about two weeks. There may be three generations a year.

Control

Spray or dust treatments with DDT or rotenone as recommended for the imported cabbageworm and the diamondback moth are usually sufficiently effective for small numbers of the cabbage looper. However, endrin is more specific for this pest and is advised when the insect population occurs in outbreak proportions. Thus, examine plants carefully before heads form for the presence of the cabbage looper and, if it is present, dust with 1 per cent endrin or spray with 20 per cent endrin emulsifiable 1 pint in 100 gallons of water. This treatment will also control all other cabbage caterpillars. Do not use endrin after heads form and follow all safety precautions concerning its use.

Zebra Caterpillar

The zebra caterpillar is velvety-black with two conspicuous bright yellow stripes on each side of the body with many narrow lines of the same colour between them.

This insect usually is not important. Occasionally in the fall the larvae become numerous enough to defoliate turnips, cabbage, and related crops. This pest also feeds on other plants such as gladioli.

The control is the same as for the imported cabbageworm.

OTHER INSECTS of CABBAGE and RELATED CROPS

Soil-infesting insects such as cutworms, white grubs, and wireworms attack this group of plants. The garden slug infests cabbage and cauliflower, especially in home gardens, often getting into the base of the heads. Turnips may also be attacked by slugs. The onion thrips, *Thrips tabaci* Lind., occasionally attacks cabbage by feeding on the lower surface of the leaves. DDT, if used for caterpillar control, usually controls the thrips adequately.

CARROT and PARSNIP

CARROT RUST FLY

Psila rosae (F.)

The carrot rust fly has been reported from almost all areas in Ontario where carrots are grown. It causes severe damage in years when the pest is plentiful in both home gardens and commercial plantings; at other times it causes little injury.

The adult is a shiny, black, two-winged fly about one-quarter of an inch long with yellowish legs and a yellow-brown head. The maggot, the stage that causes all the injury, is about one-third of an inch long when full grown, slender, almost colourless, and pointed at the front end. Larvae, pupae, and adults are shown in Figure 22.

Pants Attacked

The carrot rust fly attacks carrots, parsnips, celery, parsley, and dill.

Injury

The maggots feed on the roots of carrots, parsnips, and celery. With carrots and parsnips, most of the feeding in light infestations is in the outer portion of the roots. When very young plants are attacked, they may be killed. Injured carrots and parsnips are unmarketable (Fig. 23). With celery, they destroy many of the smaller roots of the plant.

Life History

There are two generations a year. The insects overwinter as pupae in the soil in the same field where the carrots or other hosts were grown. In the southern areas of Ontario, the flies emerge in mid-May and about a week later in northern areas. Eggs are laid singly or in groups on or in the soil near the plants. The eggs hatch in five to seven days and the young maggots attack the side roots and later the tap root. These change

to pupae about mid-July, with the second brood of flies appearing the first part of August. These lay eggs for a second generation.

Control

1. Plant carrots and parsnips as far as possible from fields that produced these crops in the preceding year.

2. Keep weeds and other plant growth from developing along ditch banks and head lands. If practical, plant square fields rather than long, narrow ones since more damage usually occurs along the edges of the plantings.

3. If earliness of crop is not important, delay planting until mid-June to avoid injury by the first brood. This, however, will not prevent late August and September injury.

4. Harvest the crop as early as possible if any rust fly is present and place the crop in cold storage. The carrot rust fly, if present at harvest time, will continue to cause damage in carrots stored in outside pits.

5. **Chemical control.** You may use before-planting or after-planting treatment as follows:

Before-planting—Apply aldrin, chlordane, or heptachlor to the soil at a rate to give 4 pounds of actual chemical to the acre for the early crop and 6 pounds of actual chemical for the late crop. Work it into the top three or four inches of soil immediately after application.

After-planting—Apply aldrin, chlordane, or heptachlor as a spray or dust to the crowns of the plants at a rate to give 2 pounds of actual



Fig. 22. Carrot rust fly larvae, pupae, and adults.



Fig. 23. Carrot rust fly injury. Note maggot in lower cross section.

chemical in each of two applications. Make the first application about June 1 and repeat in ten days. The after-planting treatment has not been satisfactory in Ontario for late storage carrots.

SIX-SPOTTED LEAFHOPPER

Macrostelus fascifrons (Stal.)

This insect and the injury to carrots are described in the discussion of insects of lettuce on page 84.

Control

Use DDT at the rate recommended for this leafhopper on lettuce as given on page 84. Make three applications at ten-day intervals in July or early August when the leafhopper migrates to the carrots.

OTHER INSECTS of CARROT and PARSNIP

These crops may be attacked by the various soil-infesting insects such as white grubs, wireworms, and cutworms.

A large green caterpillar banded with black and yellow markings occasionally feeds on the foliage; it is the larva of the black swallowtail butterfly but is of little importance. Control this caterpillar by hand picking.

CELERY

TARNISHED PLANT BUG

Lygus lineolaris (P. de B.)

The tarnished plant bug attacks a great many vegetable crops in addition to fruit, ornamentals, field crops, and other plants. It is included in this bulletin under celery because it is more important on this crop than on other vegetables, being one of our most destructive insects.

The adult is a shy, rarely seen, brownish bug with mottled areas of red or yellow. It is about one-quarter of an inch long and fragile in form, Plate E, page 58. The nymph is green or yellowish-green and in its early stage looks like an aphid, but it is much more active and quickly seeks shelter when disturbed.

Plants Attacked

This insect feeds on a great variety of plants such as celery, potato, beet, bean, and other vegetables; peach, apple, strawberry, and most other fruits; aster, dahlia, zinnia, and similar types of flowers; and alfalfa and other forage crops. Many weeds, such as pigweed, mullein, wild carrot, and ragweed, are also favoured hosts.

Injury

Both the nymphs and adults suck the sap from the plants. They may feed on the leaves, stems, or fruit, depending on the host plant. Injury to early celery is caused by the nymphs which feed on the heart of the plant. Most severe damage, however, is caused by the adult bugs that migrate to celery from weedy fields and waste land or from hay fields that have been cut, thus the injury often occurs about haying time. The bugs puncture the tender stalks and cause the plants to produce large, wilted spots and a darkening of the tissue at the joint. Injured celery does not store well and may rot more readily in storage, Plate F, page 58.

Life History

The winter is spent as adults in any protected place, such as under leaves and long grass or in brush. In April they leave their winter quarters and feed on the buds of trees and shrubs and on the new growth of perennials and biennials, and then on the early annual plants. If more favoured plants are available, they soon fly to them. Eggs are laid in May and June directly in the petioles and midribs of the leaves, in soft, new, terminal growth, or in buds or flowers. These eggs hatch in about ten days. The nymphs moult five times during a period of about three weeks before becoming adults and completing the life cycle. There are at least two broods a year in Ontario.

Control

To keep the population at a low level in any area:

1. Prevent the growth of favoured weed hosts. If pigweed or other weeds grow up and become infested during the summer, spray them to kill all plant bugs and then destroy the weeds.

2. Grow celery, if possible, in an area where there is a minimum of good wintering quarters for the pest.

3. DDT, if applied thoroughly and over a sufficiently wide area, will give good control. For the protection of celery it may be necessary to spray or dust nearby plants that are infested with the tarnished plant bug. To control blight and the tarnished plant bug in the same celery-spraying operation, add 50 per cent DDT wettable powder 2 pounds to 100 gallons of any blight spray when these pests appear in the celery or at the time of the start of haying until about four weeks from harvest. Or you may use 5 per cent DDT dust for plant bugs only. Observe all safety precautions given on the manufacturer's label in order that the DDT residue limit is not exceeded.

A mixture of dusting sulphur and hydrated lime equal parts by weight may be used in place of the DDT. These materials act as a repellent to the bugs. A ready-prepared dust mixture containing sulphur 44 pounds, hydrated lime 44 pounds, and monohydrated copper sulphate 12 pounds is available for the control of both the tarnished plant bug and blight.

OTHER INSECTS of CELERY

Carrot Rust Fly

The carrot rust fly is sometimes important on celery. It is described under Carrot on page 63. On celery the serious injury occurs on the young plants, either in the seedbed or in the field, and is caused by the maggots feeding on the small roots. Where infestations warrant treatment, use the recommendations given for carrot rust fly on carrots.

Six-spotted Leafhopper

This leafhopper is described on page 84 under Lettuce. It may carry the celery strain of the aster yellows virus to celery. Plants affected by the virus are yellowish and the leaves are somewhat curled and stunted. Screening the seedbeds against the leafhopper will prevent seedlings becoming infected with the virus. Results with DDT sprays or dusts have not been so reliable in preventing virus on celery as with lettuce.

Celery Leaf Tier, Celery Looper, Aphids

Usually these pests are not important on celery in Ontario. The DDT sprays and dusts used for the tarnished plant bug should give control of the celery leaf tier and celery looper. For aphids, use the control given under Aphids on page 11.

Cutworms, White Grubs, Wireworms

Insecticides for these pests and methods of applying them have been given previously in this bulletin.

CORN

EUROPEAN CORN BORER

Pyrausta nubilalis (Hbn.)

The European corn borer is usually the most destructive insect in sweet corn production, the prevalence fluctuating considerably from year to year. It occurs wherever corn is grown in Ontario but is far more destructive in the southern sections of the Province.

The adult is a cream-coloured moth; both female and male are shown in Figure 24. The larva, or borer, is dirty-white or sometimes pinkish, about one inch long when full-grown, and with rows of small, brown dots, as shown in Figure 25.

Plants Attacked

Corn is the main host plant, with sweet corn being preferred to field corn. Peppers are often seriously injured. Many other plants may be attacked. A few of the more common hosts are sorghum, potato, oat, barley, and bean; flowers such as aster, dahlia, and hollyhock; and weeds such as pigweed, lamb's quarters, and foxtail.

Injury

The corn borers feed on all parts of the plant. The stalks are preferred, and here the borers tunnel and cause breaking and reduction in yield. They may also be anywhere in the cob, having entered by way of the shank, through the shuck, or, particularly with second brood, the kernels at the tip of the cob. Thus it is difficult for a processor to handle corn with even a light borer infestation. Grading regulations allow only a minimum of "wormy" ears on the fresh market.

Life History

The winter is spent as full-grown borers in any part of the corn or host plant large enough to hide them. About the end of May or early in June, the larvae change to brown, cigar-shaped pupae in the same place where they spent the winter. Moths start to emerge in early June in the south part of Essex county, and later in June or early in July farther north. Eggs of the first brood are laid from the middle of June to early July, depending on the area, usually on the underside of the leaf, often near the central vein, or in small depressions in the leaf. The eggs are pearly-white, each egg smaller than a pin head, and are laid in clusters of about 10 to 30 overlapping each other like small fish scales (Plate G, page 59). The eggs hatch in four to nine days, depending on the temperature, turning almost black just before the larvae emerge. Upon hatching, the borers feed for a short time on the leaves, causing "pin-holes" in them (Plate H, page 59). **It is during this period that insecticides are effective.** In a very short time they bore into some part of the plant, usually the tassel first. As they develop, they move from the tassel down to the lower part of the stalk or cob (Fig. 25). Some may enter the cob directly, particularly if eggs were laid on the husk.

In the warmer parts of the Province a second generation occurs, with moths in August laying eggs on late-planted corn. This brood is more destructive in seasons with high average temperatures and above-normal rainfall. Both the one- and two-brooded borers spend the winter as larvae.



Fig. 24. Corn borer moths. Female at left, male at right.



Fig. 25. Corn borer at left, corn earworm at right, on a cut corn cob.

Control

Since there is no reliable way to forecast probable infestations for the year until either the end of June for the first brood or August for the second brood, use all the control methods and apply sprays or dusts according to egg and larval development.

1. Provided it is in agreement with good soil management for your farm, plough under all of the previous year's corn stalks and stubble before May 30.

2. Use varieties or hybrids that are resistant or tolerant to the corn borer. This method applies more particularly to field corn.

3. Plant sweet corn as late as possible to avoid infestation from the first brood. If earliness is desirable, use insecticides as recommended.

4. **Insecticides.** DDT and ryania are the two insecticides recommended for the corn borer. Ryania has particular value when one desires to feed stalks and husks to livestock close to time of treatment. Use 50 per cent DDT wettable powder 3 pounds, 25 per cent DDT emulsion 3 quarts, or ryania 5 pounds to the acre, applying it in 25 to 100 gallons of water. Add a spreader with ryania. Or use 5 per cent DDT dust at 30 pounds or 40 per cent ryania at 30 to 40 pounds per acre. Direct the spray or dust to the whorl, and later in the season to the whorl and cobs of the plant.

Time to treat: Apply sprays or dusts when eggs are laid, or at least not later than at time of hatch, which is indicated by feeding injury on the leaves (Plate H, page 59). For early sweet corn in a normal season this is usually the last week in June, but it is earlier in an early season. Make four applications at five-day intervals.

In Ontario granulated insecticides have had limited trials with promising results. These include DDT and some other insecticides. Equipment that will deposit the granules in the whorl and between the leaf and stalk is being developed.

CORN EARWORM

Heliothis zea (Boddie)

The corn earworm is probably the second most important insect of sweet corn in Ontario. It is known as the corn earworm in Ontario, although in more southern areas of North America, because of its importance on tomato and cotton, it also has the official common names of tomato fruitworm and bollworm. This pest is very sporadic in its attack on corn, with areas having a high infestation some years while in others it is present in only a few fields. It is more troublesome in the southern corn-growing areas of the Province.

The adult is a grayish-brown moth belonging to the same family as the cutworm moths, which it resembles. The larva, or earworm, varies in colour from light green or pink to brown or nearly black, with the underside lighter. It is marked with alternating light and dark stripes, with the middle stripe on the back usually a double line. When full-grown, a corn earworm is one and a half to two inches in length and considerably larger than a corn borer, being almost as thick as a lead pencil. Characteristics that will distinguish the earworm from the corn borer are shown in Figure 25.

Plants Attacked

This pest is a fairly general feeder, with corn being the important crop attacked in Ontario. Occasionally they injure tomatoes in this Province. Many greenhouse flowers are subject to attack, as are tobacco, bean, and many other plants.

Injury

Typical injury from the corn earworm is shown in Figure 26. The injury is almost always at the tip of the cob, where the kernels are eaten and frass is deposited. While there is wastage, processors can wash and trim earworm-infested corn with little danger of the processed product being contaminated. Infested sweet corn is likely to be completely refused for the fresh market.

Injury on tomato is described under that crop.



Fig. 26. Corn earworm and its injury.

Life History

It has not been shown that corn earworms are able to survive over winter in Ontario. They develop throughout the year in greenhouses and some may escape from here during the summer. However, it is thought that main infestations develop from moths that fly, or are blown in, from the south each year. There is also the possibility of some becoming established here upon arrival from the south in imported vegetables in the spring and early summer.

The moths may lay 500 to 3000 eggs, placing them singly on the corn silk. The eggs are yellowish and about half the size of a pinhead. They hatch in two to ten days. The larvae work down the silk and feed on the kernels and tip of the cob for two to four weeks, after which time they crawl or drop to the ground and form a burrow to pupate in. Moths emerge ten to twenty-five days later. It would appear that there are two generations a year in the southern areas.

Earworms are cannibalistic, thus it is unusual to find more than one in a cob, even though there may be more in the early stages. One earworm may injure more than one ear because sometimes they move from one cob to another.

Control

Sprays and dusts of DDT applied thoroughly to the silk of the corn at close intervals give effective control of the earworm. However, this pest is not present in large numbers every year and only rarely is serious on early corn. Unless there is evidence from moth flight or observations of eggs on the silk that earworms will be prevalent, it is questionable if it is economical to treat all fields. In areas where loss has been considerable for a number of years, treatment is advised as an insurance against loss. Sprays and dusts are not effective after the young earworms have penetrated down the silk.

The following is the spray schedule:

Spray with 25 per cent DDT emulsion 3 quarts or 50 per cent DDT wettable powder 3 pounds per acre. Apply in 25 to 100 gallons of water. The addition of 3 to 4 quarts of mineral oil (60 to 90 viscosity) will increase effectiveness. Or dust with 5 per cent DDT at 40 pounds per acre. Make four applications at four-day intervals, or three-day intervals in hot weather, starting when 25 per cent of the silks show. Direct the spray or dust onto the silk. Sprays are more effective than dusts.

CHINCH BUG

Blissus leucopterus (Say)

The chinch bug has occurred in destructive numbers in Essex and Kent counties only. The adult is about one-fifth of an inch long with a black body and white wings, which gives it a mottled appearance. The young, or nymph, is reddish in colour.

They winter as adults which lay their eggs on fall wheat in the spring. These hatch to nymphs which, after feeding for a time on wheat, may migrate to nearby corn when the wheat starts to ripen. Thus the injury appears first at the edge of corn fields, where they suck the sap from the plants. Severely injured plants may die.

Control

Watch the corn fields carefully for this insect since quick action is necessary to prevent damage. When it appears at the edge of the corn field, spray with dieldrin at a rate to give $\frac{1}{2}$ pound of the actual chemical to the acre. Thus use 50 per cent dieldrin wettable powder 1 pound, or 20 per cent dieldrin emulsifiable 1 quart, to the acre, applying it in sufficient water to obtain uniform distribution. Aldrin and chlordane also are effective but will not give protection for so long a period as dieldrin.

OTHER INSECTS of CORN

Corn Flea Beetle

The corn flea beetle, *Chaetocnema pulicaria* Melsh., has increased in numbers in southern Ontario during the last few years. The damage is caused by the adult, which is a small black beetle that jumps quickly when disturbed. It eats very small holes in the leaves of the corn plant early in the season.

The importance of this insect is that it carries the disease known as bacterial wilt of corn, or Stewart's disease. Therefore, control of the beetle also gives control of the disease. Fortunately, Stewart's disease has not been very prevalent in Ontario to date, thus very little spraying or dusting for corn flea beetle has been carried out.

Some varieties of corn are susceptible to bacterial wilt of corn, while others are quite resistant.

To control the corn flea beetle and thus Stewart's disease, spray as soon as the corn comes up if the beetle is present. Use 25 per cent DDT emulsion 1½ quarts to the acre, applying it in 10 to 100 gallons of water.

Billbugs

Several species of billbugs occasionally attack young corn plants. The adults of all of them are beetles belonging to the family Curculionidae. They are dark in colour and have long snouts. The beetles eat holes in the stems of young plants, causing the unfolding leaves that were wrapped around the stems to be perforated with transverse rows of holes. The leaves usually break over at these rows. Injury is more common following sod and particularly on land just reclaimed from marsh or swamp.

In control, do not plant corn on land that was in sod the previous year, particularly if it has been in sod for a considerable time. Fall ploughing helps in control.

Corn Leaf Aphid

The corn leaf aphid, *Rhopalosiphum maidis* (Fitch), attacks late corn more than early corn. It often develops in large numbers in the tassel and on the upper leaves of the plant. It is considered to cause little damage. As far as is known, it does not carry disease to corn. If control is desired, use the methods given under Aphids on page 11.

Corn Rootworms

Two species of rootworms attack corn—the corn rootworm, *Diabrotica longicornis* (Say), and the southern corn rootworm, *Diabrotica undecimpunctata howardi* Barber. The latter is also called the spotted cucumber beetle, the insect described on page 77. The corn rootworm

occurs mainly in southwestern Ontario, with the other species well distributed in the Province. Both insects are becoming increasingly important in the United States Corn Belt, thus Ontario growers are advised to watch for them.

The corn rootworm attacks corn only when it is planted on land that was in corn the previous year. Therefore, it is important to follow a good rotation plan. To control the southern corn rootworm (spotted cucumber beetle), apply chlordane to the soil near the plant at a rate to give 2 pounds of actual chemical to the acre, for example, 5 per cent chlordane dust at 40 pounds per acre. Work into the soil.

Seed-corn Maggot

The seed-corn maggot is nearly as destructive on corn as on beans. The description and control methods of this pest are given on page 34. Use all the control methods advised for beans to protect corn seed after planting.

Wireworms, Cutworms and Armyworms, White Grubs

Corn is very subject to attack by all of these pests. All are described elsewhere in this bulletin. Wireworms on corn are shown in Figure 4.

CUCUMBER, MUSKMELON, SQUASH, PUMPKIN

STRIPED CUCUMBER BEETLE

Acalymma vittata (F.)

The striped cucumber beetle is the most important pest of cucurbits in Ontario. The adult is one-quarter of an inch long with a black head, yellow thorax and wing covers, and three distinct longitudinal black stripes on the wing covers (Fig. 27). The larva, which is seldom seen since it develops in the soil, is slender and white with a brown head.

Plants Attacked

Cucumber, muskmelon, pumpkin, squash, and watermelon are attacked by the adult in approximately the above order. The larva develops on the roots of these and related cucurbits. The beetle feeds on many other plants such as corn, bean, and pea and the blossoms of many plants.

Injury

The beetles feed on the young plants as soon as they break through the ground, eating all but the veins of the leaves and often killing the plants. This type of injury is very important until runners are formed.

This species and the spotted cucumber beetle transmit the organisms that cause the diseases of bacterial wilt of cucurbits and cucumber mosaic. They are the sole carriers of the organism of bacterial wilt of cucurbits, which winters in the intestines of the beetles. They feed on the flowers but cause little damage to them. In the fall, beetles feed on the rind of the fruit (Fig. 28). The larvae feed on the roots but do not seem to cause serious injury.

Life History

The insects winter as adults hibernating in dense grass and under leaves and other plant remnants. In the spring, when temperatures are about 60°F. or higher, the beetles leave their winter quarters and fly to, and feed on, pollen, petals, and leaves of various plants such as willow, plum, and apple. When cucurbits are up, they fly to them and feed on the leaves and even the stems. Eggs are laid in the ground near the host plants for an extended period. These hatch in about ten days; the larvae feed on the roots for about a month, when they transform to pupae in the soil. The adults emerge in about two weeks with the new beetles feeding on the plants, including the rind of the fruit, until frost sends them to winter quarters. There is one generation a year.

Control

Prepare the soil well and fertilize so that the plants make rapid



Fig. 27. Striped cucumber beetle and feeding injury to young plant.



Fig. 28. Striped and spotted cucumber beetles feeding on rind of squash.

growth early in the season. Treat early to prevent the beetles from feeding on the seedling plants, and thus control bacterial wilt.

Cucurbits are sensitive to many insecticides and lime. DDT will cause stunting on some varieties. Thus, use only insecticides recommended for these crops.

Dust or spray as soon as plants emerge and repeat at weekly intervals. Dust with 1 per cent rotenone, 3 per cent methoxychlor, or 5 per cent aldrin, at 40 pounds per acre; or spray with 5 per cent rotenone 4 pounds, or 50 per cent methoxychlor 2 pounds, or 50 per cent aldrin 2 pounds, in 25 to 100 gallons of water to the acre.

Ready-mixed cucumber or melon dusts are available that contain an insecticide for cucumber beetle control in addition to an organic fungicide for leaf spots and anthracnose.

SPOTTED CUCUMBER BEETLE

Diabrotica undecimpunctata howardi Barber

The spotted cucumber beetle attacks a large number of cultivated crops both in the adult and larval stages. Its other common name is southern corn rootworm. The adult is a yellowish-green beetle about one-

quarter of an inch long with twelve conspicuous spots on the wing covers (Fig. 28). The larva develops in the roots.

Plants Attacked

As well as on all cucurbits, the adult feeds on bean, corn, pea, potato, beet, eggplant, tomato, cabbage, and other plants. The larva develops on many plants including cucurbits, corn, bean, grain, alfalfa, and many grasses.

Injury

The injury to cucurbits, including the spread of bacterial wilt, is very similar to that of the striped cucumber beetle except that it is usually not so severe. It is more injurious on many other crops such as beans and corn.

Life History

The seasonal development is similar to that of the striped cucumber beetle.

Control

Use the control methods given for the striped cucumber beetle.

SQUASH BUG

Anasa tristis (DeG.)

The squash bug is primarily a pest of squash and pumpkin, although it will also attack other cucurbits. Its importance is greater in the southern parts of Ontario and in home gardens.

The adult is a large, stout, dark-brown bug about two-thirds of an inch long. The nymphs, or young, are broad in proportion to length and grey in colour (Fig. 29).

Plants Attacked

All cucurbits are subject to attack, with squash and pumpkin being the preferred plants.

Injury

Both nymphs and adults suck the juice from the leaves, stems, and vines, causing light-coloured areas which later turn brown and die. Young nymphs feed in clusters but later spread out through the planting. The adults and nymphs occasionally feed on the fruit, particularly in the fall after the leaves have been killed by frost. Injury is more common in home gardens.

Life History

The winter is spent as adults in any sheltered place, under grass, rubbish, boards, or in or near buildings. Protected winter quarters are more available in home gardens than in the field. They leave winter quarters and fly to the pumpkins, squash and related crops in June, when they lay clusters of large yellow eggs, which soon turn brown, on the undersides of the leaves (Fig. 29). Eggs hatch in seven to seventeen days to pale-coloured nymphs which soon turn grey. These feed in clusters on the leaves when small but, as they develop, they separate and feed throughout the planting, reaching the adult stage in about a month. All nymphs become adults or perish before winter. There is one generation a year.

Control

1. Clean up areas where the bug finds favourable winter quarters or grow cucurbits a distance from places where the adult is able to winter.

2. Since the adult bugs congregate under boards, stones, or clumps of soil at night, place shingles or pieces of board near squash and pumpkin plants in June and each morning collect and destroy the adults that have congregated there.



Fig. 29. Squash bug. Top: five nymph stages and adult; bottom: egg cluster on leaf.

3. Collect and destroy the egg clusters in July and August.

4. Insecticides

A material such as lead arsenate is completely non-effective because this insect feeds by sucking the juice. DDT also is not satisfactory against the squash bug.

The nymph when small is easier to destroy than the larger nymph or adult; therefore, treat early when the bugs are small. Because young nymphs feed in clusters, a hand rotary duster is useful for dust application; in this way, heavily infested areas may be heavily treated without wasting material on the whole planting. Use a 3 per cent methoxychlor or 1 per cent rotenone dust at 40 pounds per acre, or spray with 50 per cent methoxychlor 3 pounds, or 5 per cent rotenone 4 pounds, in 100 gallons of water per acre. If available, pyrethrum dusts and sprays may be used.

SQUASH VINE BORER

Melittia cucurbitae (Harr.)

The squash vine borer is found in destructive numbers only in the southwestern part of Ontario in a region south of a line from Toronto to Sarnia. It is a very important pest in this area on squash, pumpkin, marrow, and gourd.



Fig. 30. Squash vine borer.



Fig. 31. Squash vines wilted by squash vine borers in stems.

The adult is an attractive clear-winged moth with black and orange body and orange legs fringed with long, black hairs. The larva, or borer, is light-coloured with a brown head and is found in the stem (Fig. 30).

Plants Attacked

Squash, pumpkin, gourd, cucumber, and muskmelon are injured in approximately the order named. Wild cucumber also is a host. Butternut, a variety of squash, is immune.

Injury

The borers enter and feed in the stems of the vines. Castings, or frass, are pushed out from the stems inside of which borers are feeding. Injured vines wilt as shown in Figure 31. Later in the season the injured area becomes thickened and may break. Even though secondary roots may develop along the vine to support it, infested plants will yield poorly and the quality of fruit will be inferior.

Life History

The squash vine borers spend the winter as larvae in cocoons in the ground. The pupae form in these cocoons in the spring. The adult moths emerge from late June until about July 15 and lay large, reddish-brown eggs either singly or in small groups on the stem near the soil. These hatch in about nine days, and the tiny borers burrow into the stem of the plant. Late in the season some may leave the stems and burrow into the fruit. The borers reach maturity in about 40 days, when they leave the stems and fruit and form cocoons in the ground. Some may emerge the same season to form a partial second brood. By fall all are larvae in cocoons in the ground ready for winter.

Control

1. In home gardens the eggs may be removed from the vines before they hatch.

2. If the borer has become established, which is evidenced by castings from the stems, slit the stem lengthwise and remove the pest. Mound earth over the injured area and over the vines near the leaves to encourage new root growth along the vine.

3. **Insecticides.** Dust the base of the plants thoroughly with 5 per cent aldrin, 2 per cent dieldrin, 3 per cent methoxychlor, or 1 per cent rotenone dust, at about 40 pounds per acre. If you use dusts of different percentage composition, say 2½ per cent, adjust rates to give the equivalent amount of insecticide per acre.

MELON APHID

Aphis gossypii Glov.

The melon aphid occasionally attacks melon and cucumber in large numbers, although many years it is not important. It is similar in form to the aphids shown in Plate A, page 56, but varies in colour from pale to dark green to almost black.

Plants Attacked

Melons and cucumbers are most commonly injured by heavy attacks, although other cucurbits also are hosts. Okra is very susceptible to the melon aphid. It attacks many other plants such as strawberry, eggplant, bean, and beet, as well as many ornamentals and weeds.

Injury

Infested leaves curl downwards and may wilt, shrivel, and become brown. In a heavy attack, individual hills or the whole field may be destroyed. This aphid is a vector of cucumber mosaic.

Life History

These aphids spend the winter in the egg stage on live-for-ever. They may also live all winter in the greenhouse. Except for the overwintering host, its life cycle is similar to that of the pea aphid as given on page 91.

Control

Since infestations of this aphid usually begin in scattered areas in the field, watch for them, and when they are seen, spot-treat. Dusts may be applied heavily to the infested areas with a hand rotary-type duster if malathion is used, or the whole planting may be treated. Since the aphids are on the undersides of leaves that will have the edges curled downwards, dusts are generally more effective than sprays.

Satisfactory treatments are a dust of 4 per cent malathion or 1 per cent freshly prepared TEPP, at 40 pounds to the acre, or a spray of 25 per cent malathion wettable powder 4 pounds, or 40 per cent TEPP liquid $\frac{1}{3}$ pint, in 25 to 100 gallons of water per acre. Apply dusts and sprays when temperatures are 70°F. or higher. Do not apply malathion when the plants are wet because it may cause injury.

OTHER INSECTS of CUCURBITS

Thrips

Some species of thrips occasionally attack cucumbers and melons when the plants are small. In most cases reported it has been the onion thrips. This insect is described on page 89.

Some of the insecticides recommended for control of the onion thrips on onion will cause injury on cucurbits. Thus, where treatment is required on cucumbers or melons, dust with 3 per cent methoxychlor, 4 per cent malathion, or 1 per cent rotenone, at 30 to 40 pounds per acre, or spray with 50 per cent methoxychlor wettable powder 3 pounds, 25 per cent malathion wettable powder 4 pounds, or 5 per cent rotenone 4 pounds, in 25 to 100 gallons of water per acre.

Two-spotted Spider Mite

This mite at times causes serious injury on cucurbits, particularly on cucumbers and melons. It is described on page 42 and illustrated in Figure 16.

To control this pest use the same insecticide recommended for the melon aphid or spray with 15 per cent Aramite wettable powder $1\frac{1}{2}$ to 2 pounds in 100 gallons of water per acre.

Seed-corn Maggot

The seed-corn maggot has become more serious on cucurbits during the last few years to the degree that some fields have required re-planting. A description of this pest is given on page 34.

Cultural control practices for this pest and the seed-protectant materials are given on page 37. In addition to applying all cultural practices suitable to your area, treat the seed with an insecticide and fungicide as recommended for beans but with slightly different rates of materials, which are given each year in the Protection Calendar for Vegetables. Or you may use a ready-mixed seed dressing containing thiram or captan along with one of lindane, aldrin, dieldrin, or heptachlor.

Cutworms, Wireworms, White Grubs

These soil-infesting insects will also attack cucurbits.

EGGPLANT

The eggplant may be attacked by many of the insects that injure tomato and pepper. Some of the most important are flea beetles, aphids, and the two-spotted spider mite. The Colorado potato beetle and tomato hornworm occasionally feed on this plant.

In control, use the same materials for the two-spotted spider mite which are recommended for this pest on page 42. Control for aphids is given under Aphids on page 11. Apply DDT dusts or sprays for flea beetles, potato beetles, or tomato hornworms.

LETTUCE

SIX-SPOTTED LEAFHOPPER

Macrostelus fascifrons (Stal.)

The six-spotted leafhopper is a very important insect in the production of lettuce because it is the principal carrier of the disease known as the aster yellows virus. It also transmits this virus to carrots and celery.

The adult leafhopper, like the potato leafhopper, is very active, slender, and about one-eighth of an inch in length. It is light greenish-yellow and has several pairs of tiny black dots on the face (Fig. 32).

Plants Attacked

The six-spotted leafhopper feeds on a wide range of plants. The important cultivated host plants are lettuce, carrot, celery, and aster.

Some weed hosts that also carry aster yellows virus are plantain, wild carrot, chicory, dandelion, perennial sow thistle, and wild aster.

Injury

Aster yellows virus carried by the six-spotted leafhoppers is one of the most important diseases of lettuce. Plants infected when they are small become yellow and dwarfed, and the inner leaves become curled and twisted (Plate I, page 60). Very few infected plants are marketable. These leafhoppers carry the disease also to carrots; infected plants have yellowish foliage, and in later stages extra shoots develop to give a witches' broom effect to the tops. The size of the roots is usually reduced and many lateral hairy roots develop (Fig. 32). Infected roots are usually off-flavour. Celery may be attacked by the celery strain of the aster yellows virus, which causes the plant to be yellow and stunted and the leaves curled.

Life History

It is likely that the six-spotted leafhoppers spend the winter in the egg stage on winter grain and grasses. The eggs hatch to nymphs in May and complete their development on these crops. The adults migrate from here to either wild or cultivated plants. If they feed on a biennial



Fig. 32. Three carrots showing varying degrees of aster yellows virus compared to normal. Inset, six-spotted leafhopper.

or perennial plant infected with aster yellows virus, these leafhoppers will become carriers of the disease and later, if they fly to and feed on lettuce, carrot, or celery, they will infect them. Once the disease is transmitted to a few plants in the cultivated crop, leafhoppers can transmit the virus from plant to plant in the same field. There are a number of generations of leafhoppers during the summer, with the last brood returning to grain and grass for the winter.

Control

Since the degree of injury to the crop is related to how early the infection of the aster yellows virus takes place, it is important to prevent the six-spotted leafhopper from feeding on young lettuce because the insects may be infected with the virus. Lettuce may be protected by thorough and frequent applications of DDT. Dust with 5 per cent DDT at 30 pounds per acre or spray with 50 percent DDT wettable powder 2 pounds, or 25 per cent DDT emulsifiable 2 quarts, in 25 to 100 gallons of water per acre at five- to seven-day intervals from the time of transplanting or emergence of the lettuce seeding until four weeks from harvest. Be sure to discontinue treatment far enough in advance of the expected harvest date so that the DDT residue will not be above the legal tolerance.

OTHER INSECTS of LETTUCE

Most of the other insects that attack lettuce are species that are found on, and often are more injurious to, other plants; therefore they are described in this bulletin under other crops.

Aphids

Aphids are sometimes important and should be controlled because they carry a mosaic virus from one plant to another. Use malathion or TEPP to control them, as given under Aphids on page 11.

Cabbage Looper

The cabbage looper may occasionally be found on lettuce. The DDT control program used for the six-spotted leafhopper usually controls it.

Cutworms, White Grubs, Wireworms, Slugs

Soil insects such as cutworms, white grubs, wireworms, and slugs attack lettuce. Control for these has been given previously in this bulletin under General Feeders.

ONION

ONION MAGGOT

Hylemya antiqua (Meig.)

The onion maggot is an important pest in all parts of Ontario where onions are grown. The infestation varies greatly from year to year, the maggot frequently being the most serious pest of onions.

The adult is a long-legged fly a little smaller than a house fly and very similar to the seed-corn maggot adult, shown in Figure 12. The larva, or maggot, and the pupa also are similar in size and form to those of the seed-corn maggot, shown in the same figure.

Plant Attacked

Onion is the only host plant.

Injury

When young onions are attacked they wilt and die, and since one maggot may destroy several seedlings close together, short sections of the row may be destroyed. Larger onions may survive an attack, but the injured bulbs will rot later or grow into unmarketable, distorted



Fig. 33. Poor stand of onions because of onion maggot.



Fig. 34. Onion maggot injury. Left: injury to small onions; right: distorted mature onions which survived early injury.

onions (Fig. 34). Injury from year to year varies from approximately 10 to 85 per cent of the total crop (Fig. 33).

Life History

The onion maggots spend the winter in the ground as pupae. The adult flies emerge in the spring and begin to lay their eggs about the time that McIntosh apple trees come into bloom. This is usually sometime during the last two weeks in May, with emergence earlier in Essex and Kent counties than farther north. The eggs are elongate, white, and laid in the soil against or near the onions. The eggs hatch in two to three days, and the maggots bore immediately into the young plants. After two or three weeks of feeding, they change to pupae in the soil and adult flies emerge about two weeks later. There are two, three, and occasionally a partial fourth generations a year. Nearly all the important injury is caused by the first brood.

Control

Because it is too late to treat for the onion maggot after the injury is noticeable, it is recommended to treat onions every year for this pest. Even in years of very light infestation, the increased yield from treatment is likely to more than pay for the insecticide.

Aldrin, dieldrin, and heptachlor are effective against the onion maggot. The four satisfactory methods of applying these materials are:

1. Before-planting treatment. Apply one of these insecticides and work it into the top two or three inches of soil immediately before planting.

2. Seed treatment. Add dieldrin or heptachlor to the seed as a seed dressing. This method is economical but is not likely to give as efficient control during a heavy attack.

3. Furrow treatment. The granulated type of aldrin or heptachlor may be used in the furrow with the seed. Dusts of these insecticides may be used in the same way.

4. After-planting treatment. Apply one of the preceding insecticides to the row when the onions are in the "loop" stage, that is, just as they are coming up, or apply it to transplanted onions as soon as they are set in the field.

Since there are several formulations for each insecticide, the rates have not been given; therefore, follow the recommendations of the current Protection Calendar for Vegetables for the exact detail.

ONION THRIPS

Thrips tabaci Lind.

The onion thrips is one of the serious pests of onions, some years being more important than the onion maggot. It occurs in all onion-growing areas of Ontario.

The adult is a very small, light yellow to brown insect with four very narrow wings fringed with hair—a pest so small that many growers do not see it (Fig. 35). The young, or nymph, is pale yellow and similar in form to the adult but smaller. Both the adult and nymph feed mostly in the protection of the leaves, which makes them still more difficult to see.

Plants Attacked

Although the most serious injury is to onion, many other crops may be damaged by this thrips, such as cucurbits, bean, tomato, cauliflower, cabbage, and corn. Many field crops, garden plants, and weeds also are hosts.

Injury

Both the adult and nymph feed throughout the season by rasping the plant tissue and then sucking the juice at these injured areas, causing small white or silvery blotches on the foliage. When thrips are plentiful, the whole field will show a whitish, bleached appearance similar to that caused by mildew (Fig. 35). Thrips injury reduces the yield considerably. Thrips-injured green onions are difficult to market because of their appearance.

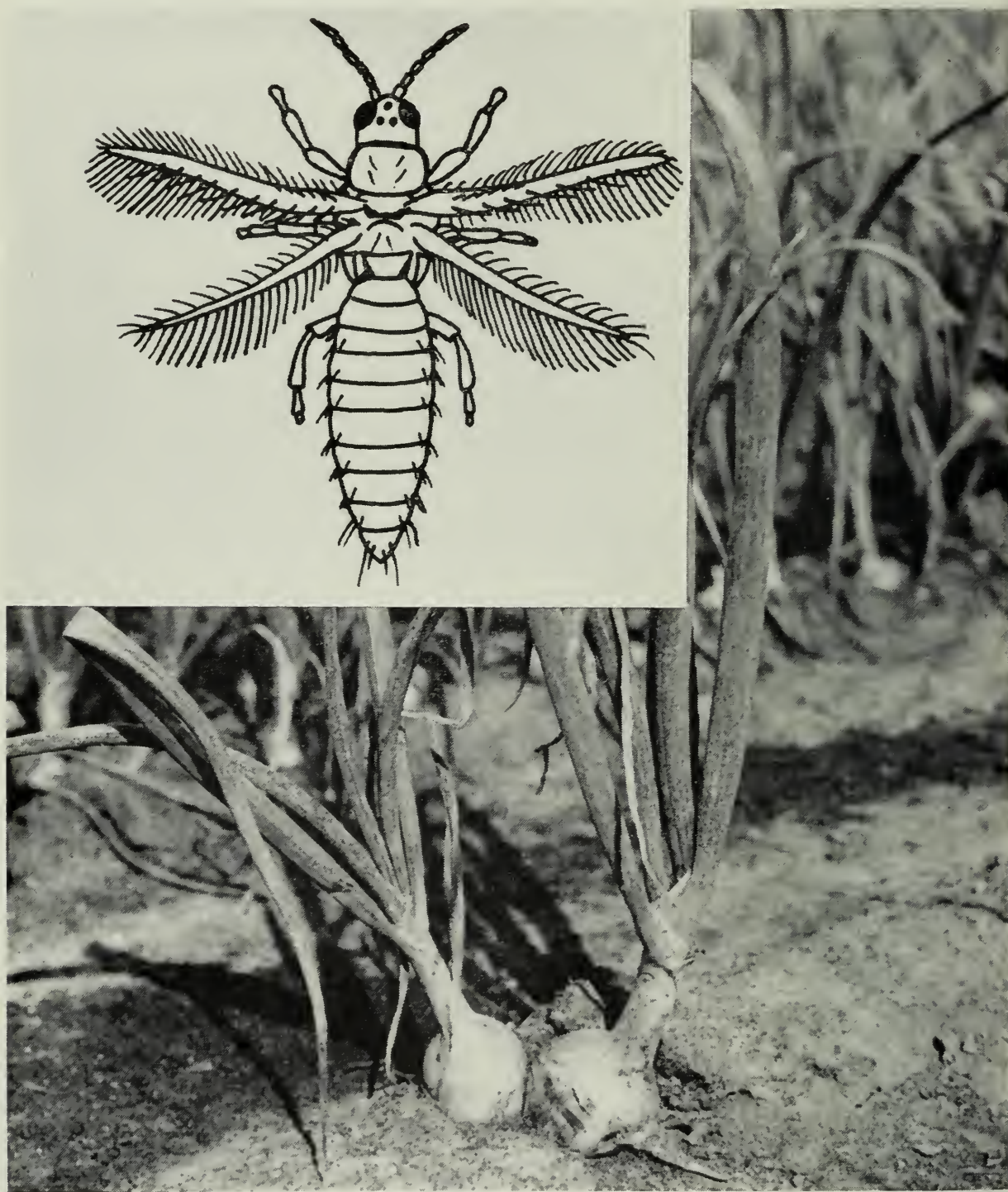


Fig. 35. Onion foliage injured by onion thrips. Inset, onion thrips.

Life History

The onion thrips spend the winter both as adults and nymphs on onions or onion refuse left in the field. They may also find protection in other plant refuse in or near the onion field. The insects may breed all winter in greenhouses and fly to the field in the spring and summer. In the spring the adults lay eggs in the leaf tissue of onions or other host plants. The eggs hatch in about four days to tiny nymphs. These go through a series of four moults in 15 to 30 days, the last two being in the ground. The females emerge and lay eggs to start a new generation. There are many broods a year.

Control

A comparison of yield of onions where the thrips was controlled with insecticides compared to that of untreated onions indicates that it is economic to spray or dust for its control. A number of insecticides will give adequate control when applied early, repeated in a week, and repeated again if the insect reappears. Thus, when it appears, dust with 5 per cent DDT, 5 per cent chlordane, 4 per cent malathion, 5 per cent aldrin, or 2 per cent dieldrin, at 30 to 40 pounds per acre. Or spray with 50 per cent DDT wettable powder 2 pounds, 25 per cent DDT emulsion 2 quarts, 25 per cent malathion wettable powder 4 pounds, 50 per cent aldrin wettable powder 2 pounds, 50 per cent chlordane wettable 2 pounds, or 50 per cent dieldrin wettable 1 pound, in 25 to 100 gallons of water per acre.

Of the insecticides listed above, use only malathion on bunching onions or spray with 5 per cent rotenone 4 pounds in 25 to 100 gallons of water per acre. Do not use malathion closer than three days from harvest on green onions.

PEA

PEA APHID

Macrosiphum pisi (Harr.)

The pea aphid is the most important insect pest of peas in Ontario.

This aphid is light green and blends in colour with the plant on which it develops. It is large compared to some other species of aphids. The nymph and adult feed together on the plant, particularly on the blooms, young leaves and pods, and growing tips (Fig. 36).

Plants Attacked

Peas, sweet peas, alfalfa, clover, vetch, sweet clover, and weeds of the legume family.



Fig. 36. Pea aphids on pea.

Injury

Both adults and nymphs suck the juice from leaves, stems, flowers, and pods, which causes the leaves to become curled and yellow, the blossoms withered, and the pods stunted and deformed. Severely attacked plants may die. Pea aphids can increase in numbers very rapidly and destroy a crop quickly, thus causing great concern to the grower and processor. Late peas are usually more severely attacked. Also pea aphids carry a virus, mosaic, to the crop.

Life History

The pea aphids overwinter in the egg stage on alfalfa, clover, and other biennial or perennial host plants. In the spring the eggs hatch to young, or nymphs, which feed on the new growth and develop through a series of moults to adult wingless females called "stem-mothers". Both nymphs and adults are similar in appearance and feed together on the

plant. Mature adults give birth to living young which develop in the same manner as the first generation. Before peas are in bloom, some winged females develop and fly to peas, where a number of generations are produced in rapid succession, all being females. If there is crowding on any of the host plants, a greater percentage of winged forms develop which fly to other plants or fields. In the fall, winged males and females develop and mate, and the females lay eggs for winter on the perennial hosts such as alfalfa and clover. A generation may develop in as short a time as 12 days in hot weather, thus there are a large number of generations in a season.

Control

1. Sow the crop as early as possible in the spring.
2. If it is practical to do so, grow peas in a field distant from perennial host plants such as clover and alfalfa.
3. **Chemical control.** Since aphids do not attack in large numbers every year because natural control factors are so important, it is recommended that the crops be treated only when an attack threatens. Watch the crop carefully from a short time before bloom until harvest and be prepared to spray or dust if aphids threaten. It is difficult to give an easy method to evaluate the probable infestation that may develop from aphids present before and at the time the peas bloom. The fieldmen of the processing companies have assisted greatly with this problem. Several methods of counting aphids in the field as a guide to time of treatment have been used, such as the number of aphids per plant or the number of aphids per sweep of a standard 12-inch insect net before or at bloom time. A method more commonly used in Ontario is to slip a narrow, pointed board between two rows and shake the aphids from the plants. Spray or dust when 25 aphids are found per square foot.

If you use sprays, apply 25 per cent parathion emulsion 1 pint, 15 per cent parathion wettable powder 3 pounds, 50 per cent malathion emulsion 1½ pints, 25 per cent DDT emulsion 3 quarts, or 40 per cent TEPP liquid ½ pint, in 10 to 100 gallons of water per acre. For dusts, use a rate to give the same or slightly higher amounts of actual chemical to the acre compared to those for sprays.

Early Treatment. In an area where mosaic is an annual threat, it may be advisable to spray as soon as the peas show in the rows; this kills the aphids that migrate to the pea fields before they feed on the plants and will prevent the plants from becoming inoculated with the virus.

PEA WEEVIL

Bruchus pisorum (L.)

Many years ago the pea weevil was the worst pest of peas, and many growers were forced to discontinue this crop because of it. During the last few years it has been important only in a few areas of Ontario, particularly from Huron county east to York county. It is a potential threat to all types of peas at all times.

The adult is a stout, oval, brownish beetle about one-fifth of an inch long with white and black mottling on its back. Its wing covers are short and do not cover the tip of the abdomen. Adults are shown in Figure 37. The grub and pupa develop inside the pea seed.

Plants Attacked

Peas.

Injury

The larvae, or grubs, feed inside the pea seeds where they hollow out cavities for the larval and pupal stages. Unless one cuts the seed, it is difficult to identify infested peas until the pupal stage. Note by Figure 37 that there is only one weevil per seed and that they do not leave it until the adult stage. An infested crop will be rejected by the processor because it is impossible to remove all infested peas at processing time.

Life History

The pea weevils spend the winter as adults either in the seed, granary, or barn, or in debris or any sheltered place in or near the field where peas were grown the preceding year. Before or during the time the peas bloom, they fly from these places to the field, where the adults feed for a short time on the pollen, petals, leaves, and pods. The females deposit elongated, yellowish eggs on the outside of the pods with usually one to ten on a single pod. The eggs hatch in five to eighteen days, and the larvae burrow through the pod and enter the seeds, where they feed on the inner part. They require four to six weeks to develop and, before they pupate, they eat a small channel to the seed coat, but not through it. Thus an infestation is difficult to detect until just before the pupal period. In two weeks the pupae change to adults which may remain in the seed for some time or may immediately chew through the seed coat and emerge. They do not develop in dried peas, thus there is no increase in storage.

Control

1. If the pea weevil is abundant in the area, and unless all growers carry out a complete spray or dust program, it may be necessary to discontinue growing peas for at least a year.



Fig. 37. Pea seed showing pea weevil injury. Note that some adults have emerged from the seed.

2. Do not grow peas for processing and peas for seed or grain in the same area.

3. If there are weevils in seed or grain, fumigate it as soon as harvested. Sow only weevil-free or fumigated seed.

4. Plough all pea fields immediately after harvest to destroy any peas left there.

5. **Chemical control.** The control with insecticides is difficult since it is necessary to sweep with an insect net to determine the correct time for treatment. Apply sprays and dusts when the adult weevil migrates to the fields, which is usually just before the peas bloom and continues during, and for a short time after, bloom. If one weevil is found in 100 sweeps of a standard insect net, apply treatment. Repeat sweepings every

four or five days and dust or spray again if weevils are found. Two or three treatments may be required. Spray with 15 per cent parathion wettable powder 11½ pounds, 50 per cent methoxychlor wettable powder 3 pounds, 50 per cent DDT wettable powder 2 pounds, or 25 per cent DDT emulsion 2 quarts, in 10 to 100 gallons of water per acre. For dusters use 1 per cent parathion dust at 40 to 50 pounds per acre or 5 per cent DDT dust at 25 to 30 pounds per acre. Parathion is likely to give the best control, but you must observe all safety precautions when you apply it.

PEA MOTH

Laspeyresia nigricana (Steph.)

The pea moth has not been important in Ontario but is included in this bulletin because it has been occasionally troublesome in Quebec and the Maritimes and may in the future be important here.

The adult is a small moth. The injury from the larvae is shown in Figure 38.

The habits and control of this pest are given in Entomology Processed Publication 107 (1948) available from Information Service, Canada Department of Agriculture, Ottawa, Ontario.



Fig. 38. Injury of the pea moth.

OTHER INSECTS of PEA

Seed-corn Maggot

The seed-corn maggot is a very serious pest of peas, especially during cold, wet season. Control is the same as that for Bean, page 34. It is advised that pea seed be treated before planting as recommended for beans.

Bean Weevil

The bean weevil also attacks peas. This insect is described on page 40.

Cutworms, Wireworms, White Grubs

Cutworms attack peas. Soil-infesting insects such as wireworms and white grubs attack peas, but usually they cause less serious injury to peas than to other crops. Control for these pests is given elsewhere in this bulletin.

PEPPER

There are very few insects in Ontario that are specific to peppers alone; however, a large number that are more injurious to other crops also attack peppers. This crop is often produced satisfactorily in the home garden with no insecticide treatment.

European Corn Borer

The corn borer moths may lay eggs on peppers and the borers then enter the stems and pods. Decay organisms usually gain entrance to infested pods, which then rot, although occasionally there is little evidence of injury from the outside.

DDT and ryania are effective against the corn borer on peppers, but only ryania can be used on the pods. Apply two sprays or dusts of DDT or ryania at the rate recommended under Corn Borer on page 68 when early planted sweet corn is treated, and about the middle of August spray with 100 per cent ryania 5 pounds in 25 to 100 gallons of water per acre or dust with 40 per cent ryania at 40 pounds per acre. Add a spreader to the ryania spray. Several treatments in August may be required.

Aphids.

Aphids quite often attack peppers. It may not be necessary to treat for aphids every year, but when they are found apply a spray or dust as recommended under Aphids on page 11.

Tomato and Tobacco Hornworms

These insects are occasionally found on peppers. To control them, hand pick and destroy if there are only a few, or use the sprays or dusts which are recommended for these pests on page 108.

Cutworms, Wireworms, White Grubs, Slugs

Cutworms may eat the plants off at or near ground level. Wireworms feed in the root and stem and may destroy newly set plants. White grubs eat the roots. Slugs eat holes in the pods, particularly those that touch or are near the ground. Control for these pests is given under General Feeders.

POTATO

COLORADO POTATO BEETLE

Leptinotarsa decemlineata (Say)

The Colorado potato beetle is one of the best-known vegetable insects in Ontario. It occurs wherever potatoes are grown in this Province. It was one of the most important pests of potatoes before 1940, but since that time it has been less abundant, with only occasional serious injury occurring.

The adult is the familiar yellow- and black-striped beetle shown in Figure 39. The larva, or "slug", is soft-skinned, hump-backed, and brick-red in colour, and has two rows of black dots on each side of the body.

Plants Attacked

Potatoes are preferred to any other plant. The potato beetle also feeds on tomato, eggplant, tobacco, pepper, and some weeds, particularly weeds of the nightshade family.

Injury

Although both the adults and larvae feed on the foliage, most of the damage is done by the larvae. Potato beetles may completely defoliate the plants and leave only the stems and roots.

Life History

The adult beetles spend the winter in the soil at a depth of about six inches. They leave the soil in the spring, often before potatoes are up, and as soon as the plants are up they lay their orange-yellow eggs in clusters on the undersides of the leaves, averaging about two dozen to



Fig. 39. Colorado potato beetle.

a cluster. The eggs hatch in about a week; the larvae feed for two to three weeks before reaching maturity and then pupate in the ground. Because the eggs are laid in clusters, it is quite common for a plant that has had one egg cluster laid on it to be defoliated before pupation takes place. The pupal stage lasts about a week. When the adults emerge, some of them lay eggs to form a partial second generation. All are in the adult stage when they enter the soil in the fall.

Control

It is necessary to spray or dust for potato beetles and other leaf-feeding insects every year. Many insecticides will control them. DDT is most commonly used and is applied at the rate of 50 per cent DDT wettable powder 2 to 3 pounds, or 25 per cent DDT emulsion 2 quarts, to 100 gallons of spray. The insecticide is almost always combined with a fungicide. If dust is preferred, apply 5 per cent DDT dust at 25 pounds per acre. A spray or dust program for potatoes that includes control recommendations for the common insects and diseases that attack the foliage is given each year in the Protection Calendar for Vegetables or Field Crops.

POTATO FLEA BEETLE

Epitrix cucumeris (Harr.)

The potato flea beetle is one of the most important leaf-feeding insects of potatoes. It occurs wherever potatoes are grown in Ontario.

The adult is a small black beetle about the size of a pin head. The hind legs are developed for jumping, which suggests the common name. The larva is a whitish, slender, cylindrical grub that develops in the ground and is rarely seen.

Plants Attacked

Potato and tomato are the common host plants but this flea beetle feeds on many other plants, both cultivated and wild, for example, pepper, eggplant, tobacco, and weeds of the nightshade family.

Injury

The most serious injury is caused by the beetles eating shot-like holes in the leaves, particularly early in the season, as shown in Figure 40. The beetles may carry disease organisms to the plant and these may gain entrance to the leaf more readily at injured places.

The larvae occasionally feed on the tubers and cause pimple-like eruptions on the surface with shallow, winding trails beneath or they make feeding tunnels into the tuber one-fourth inch or deeper. These tunnels are often called "slivers" because of their appearance in cut or peeled potatoes.



Fig. 40. Potato flea beetle injury.

Life History

The potato flea beetles develop in a similar manner to the striped flea beetles described on page 49, although the preferred host plants are different. Potato flea beetles have one generation a year.

Control

The potato flea beetle is more difficult to control than most of the other leaf-feeding pests. Since the most serious injury occurs early in the season, start spraying or dusting as soon as this insect appears on the plants. Apply DDT as given for the Colorado potato beetle.

POTATO LEAFHOPPER

Empoasca fabae (Harr.)

The potato leafhopper, unless controlled, is often the most serious leaf-feeding insect on potatoes. It is present throughout the Ontario potato-producing areas.

The adult is a small, pale green, wedge-shaped insect about one-eighth of an inch long. The hind legs are well developed for jumping. The nymph, or young, is similar in form to the adult but has no wings. It resembles a small aphid but moves more quickly and does not have cornicles, or tubes, on the abdomen.

Plants Attacked

In addition to potato, it attacks bean, apple, plum, alfalfa, clover, many other cultivated crops, and a large number of weeds.

Injury

Both the nymphs and adults suck the juice from the leaves. When they insert their mouthparts to feed, they injure the leaves by possibly injecting a poison that causes the tips and edges to turn brown and die. The condition is known as "hopperburn" (Plate J, page 60).

Life History

It is not known whether the potato leafhoppers are able to overwinter in Ontario. If they do not, then they fly, or are blown, in from southern areas. They appear in very large numbers on bean, fruit trees, and other plants early in the season, and when potatoes are well started they migrate to them. They lay their eggs in the large veins and stems. These eggs

hatch in about ten days and the nymphs become full-grown in about two weeks. The nymphs are very active and are able to run sideways on the leaf, a characteristic that may be used to distinguish them from aphids. There are two full generations in Ontario and possibly partial third and fourth broods in southern areas of the Province.

Control

DDT has been very effective in controlling this pest. Use the rate given for the Colorado potato beetle.

POTATO APHIDS

Aphids are not usually a serious pest of potatoes in Ontario, but occasionally they develop in large numbers. They are important in seed production as vectors of virus diseases.

There are several species which are all similar in general appearance to Plate A, page 56. The potato aphid, *Macrosiphum solanifolii* (Ashm.), and the green peach aphid, *Myzus persicae* (Sulz.), are usually the most abundant. The buckthorn aphid, *Aphis abbreviata* Patch, and the foxglove aphid, *Myzus solani* (Kltb.), also occur.

Plants Attacked

These species of aphids attack many other plants; in fact, as the common names imply, potatoes may not be the preferred host.

Injury

Aphids suck the sap from the leaves and stems and may reduce yields considerably. They are important vectors of some of the virus diseases, particularly leaf roll.

Life History

The development of these aphids is, in general, similar to that described under Aphids on page 11.

Control

DDT in the regular sprays which are recommended for other leaf-feeding insects usually gives adequate control of aphids, especially if DDT emulsion is used. If aphids become plentiful, use materials recommended under Aphids on page 11. Malathion has been the preferred material in Ontario.

WIREWORMS

Several species of wireworms attack potatoes, which is one of the crops most susceptible to injury by these pests. Wireworms and their injury to potatoes are shown in Figure 5. Their habits and life history are given under Wireworms on page 18.

Control

Use the methods given on page 18. Do not place the insecticide too deep, that is beside or below the seed piece at planting time because this will give inefficient control.

If wireworms are discovered in the seed pieces within three weeks of planting, an emergency treatment of 5 per cent aldrin granular at 40 pounds, or 2½ per cent heptachlor granular at 80 pounds per acre may be applied four to six inches deep and in a band on both sides at four inches distance from the potato row. This method is not so reliable as before-planting treatment.

WHITE GRUBS

Phyllophaga spp.

White grubs are one of the most injurious insects on potatoes, the potato being one of the favourite food plants of this pest. The injury from white grubs is shown in Figure 5.

The control is given in the section on White Grubs on page 21. The only exception to recommendations given previously is that when the insecticide is mixed and applied with the fertilizer it is not likely to give effective control if the mixture is placed beside or below the seed piece, because at this level the insecticide is too deep to be effective.

OTHER INSECTS of POTATO

A large number of insects in addition to those already described attack the potato, and during certain years these may be important. Some of them are briefly referred to below.

Tarnished Plant Bug

The tarnished plant bug sucks the juice from the leaf stems and tips of the plants. The leaf or tip often breaks over at this injury, causing dead tips or leaves. Occasionally it injures a considerable number of plants.

This insect is described under Celery on page 66, and the adult bug is shown in Plate E, page 58. The DDT sprays and dusts recommended for the Colorado potato beetle will give control if applied thoroughly.

Blister Beetles

Several species of blister beetles attack and eat the foliage of potatoes. They are more common in the northern potato-growing areas. They are slender beetles with soft wing covers and, according to the species, may be grey to black in colour or have yellowish or grey stripes. They feed on a large number of plants. The damage is caused by the adult beetles.

Since the beetles are voracious feeders, apply control promptly if they attack the potatoes. DDT as recommended for the Colorado potato beetle is effective, or use 5 per cent chlordane dust at 20 to 25 pounds to the acre.

Potato Scab Gnat

This insect, *Pnyxia scabiei* (Hopk.), occasionally attacks potatoes in Ontario. The larva is a very small, grub-like form that develops near the surface of the tuber in scab lesions or in other injuries on the surface of the tuber.

Potatoes grown in acid soil are seldom affected by this pest. Crop rotation will help control the potato scab gnat.

Common Stalk Borer, Corn Borer

While these borers occasionally develop in the stems of potatoes, it is unusual for them to be plentiful enough to be important.

Seed-corn Maggot

If potatoes are very slow in coming up, the seed-corn maggot, which is the same insect described under Bean on page 34, may infest the seed pieces.

There is no chemical treatment to protect potato seed pieces from attack. There will be very little trouble if the soil is warm and not too wet at planting time.

Slugs

The common slug eats holes in potato tubers which are similar to those caused by white grubs. These holes are usually smaller, with an opening through the skin which is often smaller than the diameter of the eaten area underneath. These pests cause more injury in home gardens than is generally realized. Slugs and their injury are described on page 24.

Millipedes

Millipedes are often found in potato tubers at harvest time in the injuries caused by slugs, wireworms, white grubs, and other pests. While they may increase the injury, it is not usual for them to attack healthy tubers. Practices that will reduce injury to the tubers from other causes will help control millipedes.

RHUBARB

RHUBARB CURCULIO

Lixus concavus Say

The rhubarb curculio, although not of great importance, occasionally marks rhubarb stems, especially in home gardens.

The adult is a large black snout beetle about one-half of an inch long and covered with a rusty powder (Fig. 41).

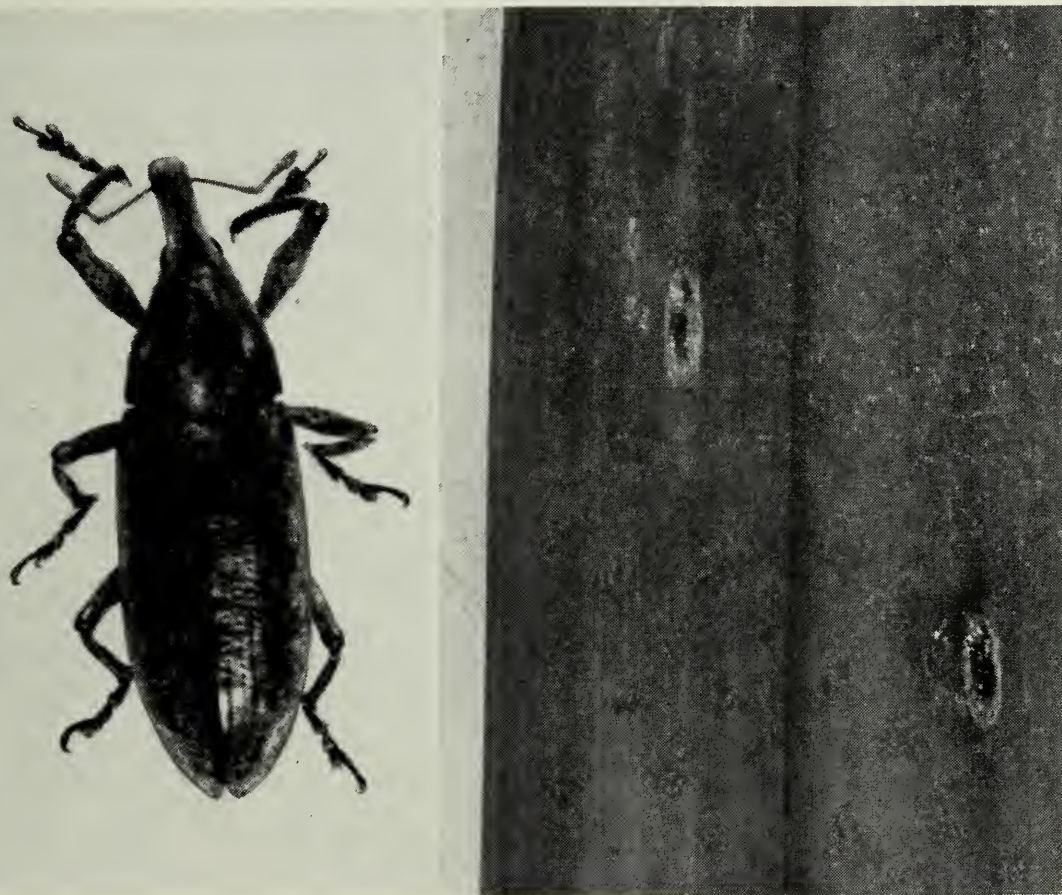


Fig. 41. Rhubarb curculio and two egg-laying scars on rhubarb stalk.

Plants Attacked

Common curled dock is the principal host plant, although it has been reported on thistle and sunflower. Eggs are laid on rhubarb but the larvae fail to develop on it.

Injury

The adult bores a hole in the stem with its mouthparts and then lays an egg in the puncture. The larva rarely develops in rhubarb, thus a scar on the stalk is the only injury (Fig. 41).

Life History

These insects winter as adults and lay eggs in curled dock and rhubarb stems in June and July. The larvae that hatch in rhubarb soon die, but those in dock bore down the stem as they develop and finally pupate near the ground. Adults emerge in September and find a protected place in which to spend the winter.

Control

Since this insect completes its life cycle only on curled dock, control this weed in an area where rhubarb is grown.

SPINACH

SPINACH LEAF MINER

Pegomya hyoscyami (Panz.)

This is the most important insect that attacks spinach. In some years this pest is quite plentiful and destructive while at other times it is almost absent from cultivated host crops.

The adult is a fly and the larva is a maggot which, along with the pupa, is similar in appearance to the seed-corn maggot shown in Figure 12. The leaf miner larva, however, infests the leaf rather than the germinating seed.

Plants Attacked

Spinach, beet, and chard are preferred of the vegetables. It also attacks sugarbeet, mangold, lamb's quarters, pigweed, and some other weeds.

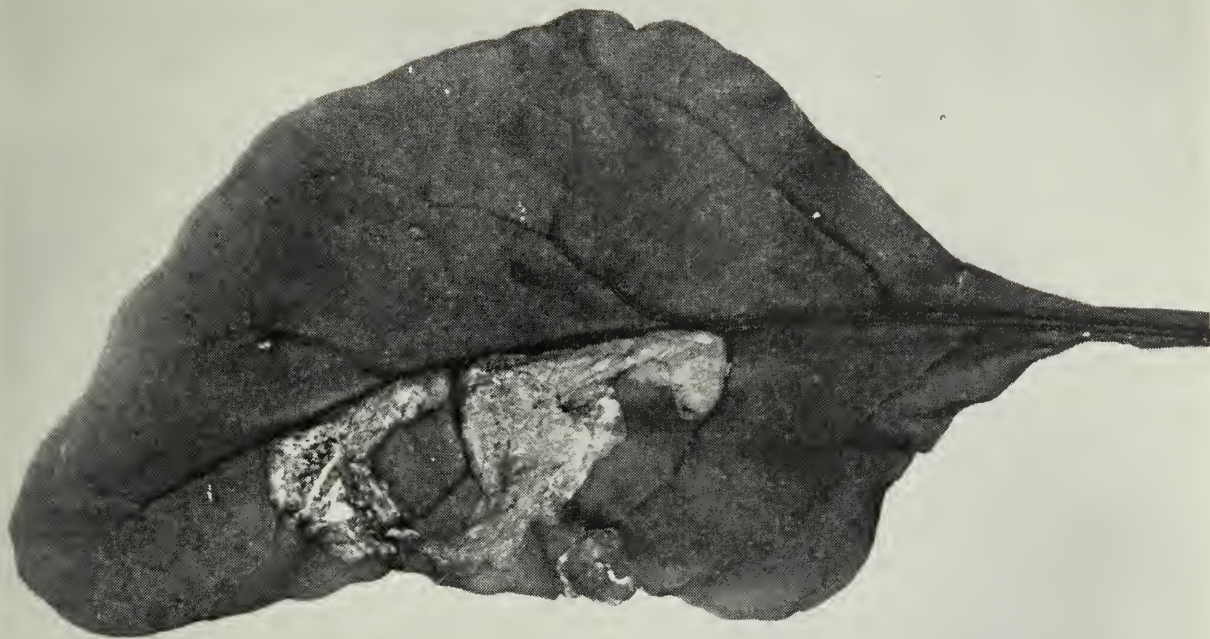


Fig. 42. Spinach leaf miner injury.

Injury

The larva, or maggot, feeds between the upper and lower surface of the leaf on spinach and beet in particular. This causes blasted spots or blister-like blotches in the leaf (Fig. 42). The injury is usually not important on beets unless the leaves are used as a green vegetable or where "bunched" beets are marketed with the tops on.

Life History

The spinach leaf miners spend the winter in the soil in the pupal stage. The adult flies emerge in May and early June and deposit eggs on the undersides of spinach leaves or on leaves of other host plants. The eggs hatch in four or five days and the maggots bore directly into the leaves where they first make a slender, winding mine between the leaf surfaces, later widening this to form the blotches shown in Figure 42. A larva usually moves to one or even two adjacent leaves before leaving as a mature form and going into the ground to pupate. The larval period takes one to two weeks and the pupal period two to four weeks. Adults emerge and lay eggs on the new plants. There are usually two, with a partial third, generations a year.

Control

1. Control weeds such as lamb's quarters and pigweed.
2. Grow the crop under optimum conditions in order to market it before the insect infests the leaves.
3. Plough down all spinach, beet, and chard refuse immediately after the crop is harvested, particularly if a succession of spinach crops are to be grown.
4. Chemical control. Malathion will control the very young larva if thoroughly applied on a hot day. As soon as the first small "mines" show, apply 4 per cent malathion dust at 30 to 40 pounds per acre or spray with 25 per cent malathion wettable powder 4 pounds in 25 to 100 gallons of water per acre. Do not apply sprays or dusts closer than seven days from harvest

OTHER INSECTS of SPINACH

Many other insects attack spinach but most of them are not specific to this crop and usually are not very important. Aphids occasionally are a problem, the common species being the green peach aphid. Control for them is given under Aphids on page 11. Use only malathion, TEPP, or nicotine within one week, or TEPP or nicotine within three days, of harvest to avoid poisonous residues on marketed crop.

Cutworms and various soil-infesting pests may at times be a problem. Control for these is given earlier in this bulletin under General Feeders.

TOMATO HORNWORMS

Two species of hornworms attack tomatoes namely, the tomato hornworm, *Protoparce quinquemaculata* (Haw.), and the tobacco hornworm, *Protoparce sexta* (Johan.). The tomato hornworm occurs wherever tomatoes are grown in Ontario, and the tobacco hornworm, while found all along the north shore of Lake Erie and in small numbers along Lake Ontario, has been present in destructive numbers mainly in Essex, Kent, Middlesex, Elgin, and Norfolk counties.

The adults of both species are large grey moths with wingspreads of four to five inches (Fig. 43). The larvae of both species are similar in appearance and difficult to tell apart when young. Older larvae are alike in size and form but the tomato hornworm has eight white, V-shaped marks on each side and the horn is dark in colour (Fig. 44), whereas the

tobacco hornworm has seven oblique, white marks and the horn is red and curves slightly downward at the tip.

Plants Attacked

Tomato and tobacco are the principal host plants. They also feed on potato, pepper, eggplant, and weeds related to these crops.

Injury

Both species of hornworms eat the leaves. They also eat large areas from the fruit.

Life History

Hornworms spend the winter as pupae in the ground in or near the field where tomatoes or tobacco were grown during the preceding year. The adults emerge in late June and July and soon lay eggs on tomato leaves. Caterpillars hatch in four or five days and feed on the leaves and fruit for 20 to 30 days, after which time they enter the ground to pupate. Some remain in the ground until the next year, while others emerge in August to form a second generation. All are pupae in the soil by fall.



Fig. 43. Tomato hawk moth.

Control

1. Hornworms are often heavily parasitized, as shown in Figure 45, thus they do not always require chemical control.

2. Hand pick and destroy them in home gardens.

3. DDD (TDE), lead arsenate, and calcium arsenate will kill both species. Use 5 per cent DDD (TDE) dust at 30 to 40 pounds per acre or spray with 50 per cent DDD (TDE) 3 pounds, lead arsenate 5 pounds, or calcium arsenate $2\frac{1}{2}$ pounds, in 25 to 100 gallons of water per acre.

DDT is effective against the tomato hornworm only, and in areas where the tobacco hornworm is not present, you may dust with 5 per cent DDT at 30 to 40 pounds per acre or spray with 50 per cent DDT wettable powder 3 pounds in 25 to 100 gallons of water per acre.

Insecticides for hornworms are usually added to fungicide sprays in order to control insects and diseases at the same time.



Fig. 44 Tomato hornworm. Note that the leaves and fruit have been eaten.

TOMATO RUSSET MITE

Lasates lycopersici (Masse)

The tomato russet mite occasionally appears in spots in the field or in greenhouses in Ontario. This mite is not able to overwinter here except in greenhouses and, since it cannot fly, local infestations in the field come from plants previously infested in the greenhouse or from imported plants. It has not been a serious pest, but an infested area in the field is conspicuous.

This pest is a true mite, rather than an insect, and so small that a high-powered hand lens is required to see it.

Plants Attacked

Tomato is the only plant where injury has been recorded in Ontario. It is present on other plants of the nightshade family in the southern part of the United States.

Injury

The leaves and stems of infested plants become russeted and bronzed. If the infestation continues, the stems crack, the fruit becomes bronzed, and in time the plant dies. Since there are no winged forms, infestations usually remain in patches in the field.

Life History

Reproduction of the tomato russet mites is continuous where temperatures are high enough. They develop from egg to adult in seven days at temperatures of 70°F. Prolonged periods of freezing will kill all stages.

Control

Treat only infested areas. Apply a fine sulphur dust or spray, using microfine sulphur at a rate to give 6 pounds of actual sulphur to 100 gallons of water.

Certain miticide sprays are also effective when used as directed by the manufacturer.

FLEA BEETLE

The potato flea beetle attacks the tomato about as readily as it does the potato. This insect is described on page 99.

It causes the most severe injury on tomatoes just after the plants have been transplanted to the field and before they have become well established. It eats numerous small shot-like holes in the leaves similar to the injury shown on potato in Figure 40. A severe attack will reduce the yield. It does not injure the fruit directly.

Control

Before transplanting the plants to the field, spray them with DDT, using 50 per cent DDT wettable powder 2 ounces in 5 gallons of water. If the plants were not treated before planting and the flea beetle attacks, spray with 50 per cent DDT wettable powder 2½ pounds in 100 gallons of water. Do not make more than two applications because numerous DDT treatments will stunt tomato plants.

APHIDS

The same species of aphids that attack potatoes also attack tomatoes. Generally the aphids are not numerous enough to require control, but sometimes it is necessary to spray early staked tomatoes and occasionally field tomatoes.

Control

Use one of the materials given under Aphids on page 11.

TOMATO FRUITWORM (Corn Earworm)

Heliothis zea (Boddie)

The tomato fruitworm, or corn earworm, rarely attacks tomatoes in Ontario. However, in 1954 this pest infested tomatoes in southwestern Ontario to the extent that processing factories were forced to discontinue operations in September.

Injury

The larvae eat into the fruit at any time during its development. During the attack in Ontario in 1954, many fruitworms developed inside the tomato, with little evidence of infestation on the outside, thus making it impossible to harvest and process any of the crop after it had become infested. Because of this habit, this pest is a potential threat to Ontario field-grown tomatoes at any time.

Life History

This insect is discussed under Corn Earworm on page 69. The larva is shown in Figure 25.

Control

It is very difficult to state when sprays should be applied for this pest on tomatoes. If tomato-fruitworm eggs have been laid on the crop or if it is forecast from the abundance of first brood or moth flight that there is likely to be an attack on tomatoes, spray with 50 per cent DDT wettable powder 3 pounds, or 50 per cent DDD (TDE) wettable powder 3 pounds, in 100 gallons of water. Either of these materials may be combined with a fungicide spray.

OTHER INSECTS of TOMATO

Grasshoppers and Crickets

If grasshoppers and crickets are present in fields adjoining tomatoes in August and September, they are likely to migrate to the tomatoes and feed on the leaves and fruit. They often eat the skin of the fruit and may cause considerable damage.

Grasshoppers and their control are described on page 16. If they start to invade tomato fields, spray or dust the borders with one of the insecticides given under Grasshoppers on page 16. These materials may be applied directly to the crop before the picking season, provided the safe interval from treatment to harvest is observed. If grasshoppers or crickets are in the tomato field during the picking season, use only poison bait because the bait will not leave insecticidal residues on the fruit.

Stink Bugs

The green stink bug occasionally feeds on both green and ripening tomatoes. It punctures the skin with its sharp mouthparts and sucks the juice. The area around the puncture becomes corky and hard, and the skin in this area does not develop its full red colour. Fruit injured by the stink bug may be out of grade.

Stink bugs develop on weeds, legumes of all kinds, and other plants. Injury to tomatoes in Ontario has been in fields adjacent to alfalfa, indicating that the bugs came from this field.

Control is difficult. Keep weeds under control and, if this pest has caused injury in the area, grow tomatoes at a distance from alfalfa, clover, and other legumes. Dusts of 2½ per cent heptachlor and 2½ per cent



Fig. 45. Hornworms with pupae of a parasite on their backs.

dieldrin are claimed to be effective, but they must be applied far enough in advance of harvest to avoid residues on the fruit.

Cutworms, Wireworms, White Grubs, Aphids, Two-spotted Spider Mite

Cutworms in particular may cause serious injury to tomatoes. Control for all these pests is given under General Feeders.

Slugs, Millipedes

These two pests are more troublesome in home gardens, where they feed in cracks or injuries in the fruit. Usually they are not important on field tomatoes.





L I M E A C I D S O I L S F O R B E T T E R Y I E L D S

CARONAF6
B523

O N T A R I O A G R I C U L T U R A L C O L L E G E
G U E L P H , O N T A R I O



O N T A R I O D E P A R T M E N T O F A G R I C U L T U R E

P A R L I A M E N T B U I L D I N G S , T O R O N T O , C A N A D A

Dr. C. D. GRAHAM
Deputy Minister

Honourable W. A. GOODFELLOW
Minister

LIME ACID SOILS FOR BETTER YIELDS

By Prof. T. J. HEEG, Department of Soils

Good crop yields are the result of proper co-ordination of all the factors in production.

Let us liken the farmer to the coach of a hockey team. It is one thing to have good players, but unless they work together, they won't win games. The farmer's players are all the factors in crop production, and if one factor is weak, his goals will be limited. Acid soils can be one of these weak factors, but a soil test will indicate how much lime is needed. A good coach will want to know the necessary treatment and apply it in the proper way.

DIAGRAM 1

COACH FARMER

Is YOUR team
ready to score
with ADEQUATE
yields?



GOOD TILTH
PROPER TILLAGE



EROSION CONTROL



LIMESTONE



ORGANIC MATTER
SUPPLIED BY
GOOD ROTATIONS

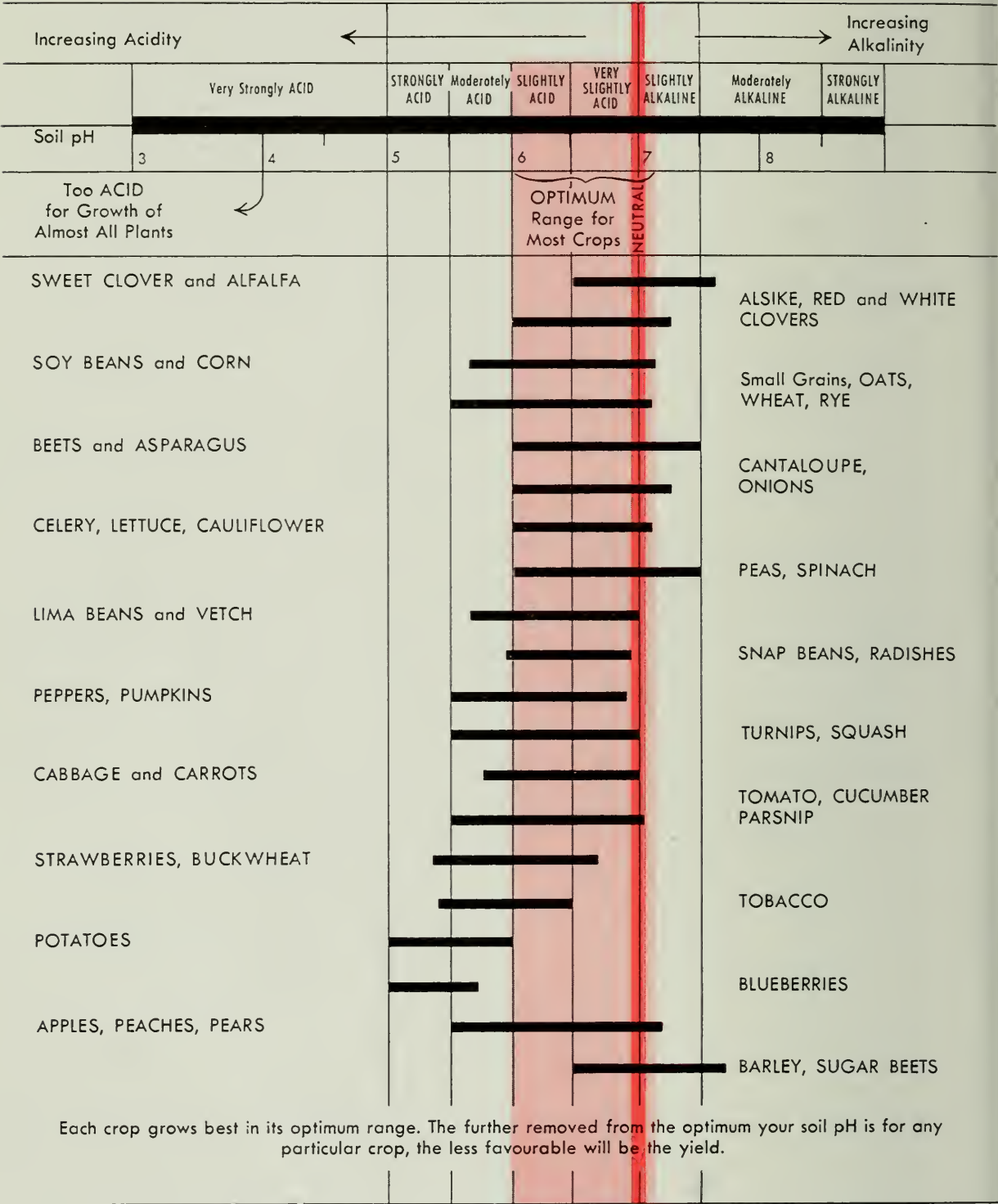


SOIL TESTS



FERTILIZER

OPTIMUM SOIL REACTION RANGES FOR CROPS



What is soil reaction?

Soil reaction is the term used to describe the acidity or alkalinity of a soil. The intensity of the soil reaction is measured in the chemist's term of pH.

The pH scale runs from 0 to 14. Halfway between, or pH 7.0, is neutral. Numbers below 7 are acid, while those above are alkaline. The lower the number, the more acid is the soil and, similarly, the higher the number, the more alkaline it is.

The diagram below gives the reaction of some commonly known products and illustrates various degrees of acidity and alkalinity expressed by pH.

Although the acidity of orange juice is relatively mild, a similar soil pH of 4.0 is very acid for most plants and they will find it difficult to grow in it. Good soils will have values ranging from 6.2 to 7.5, but the range of pH in soils generally used for crop growth is from 4.5 to 8.5.

DIAGRAM 2



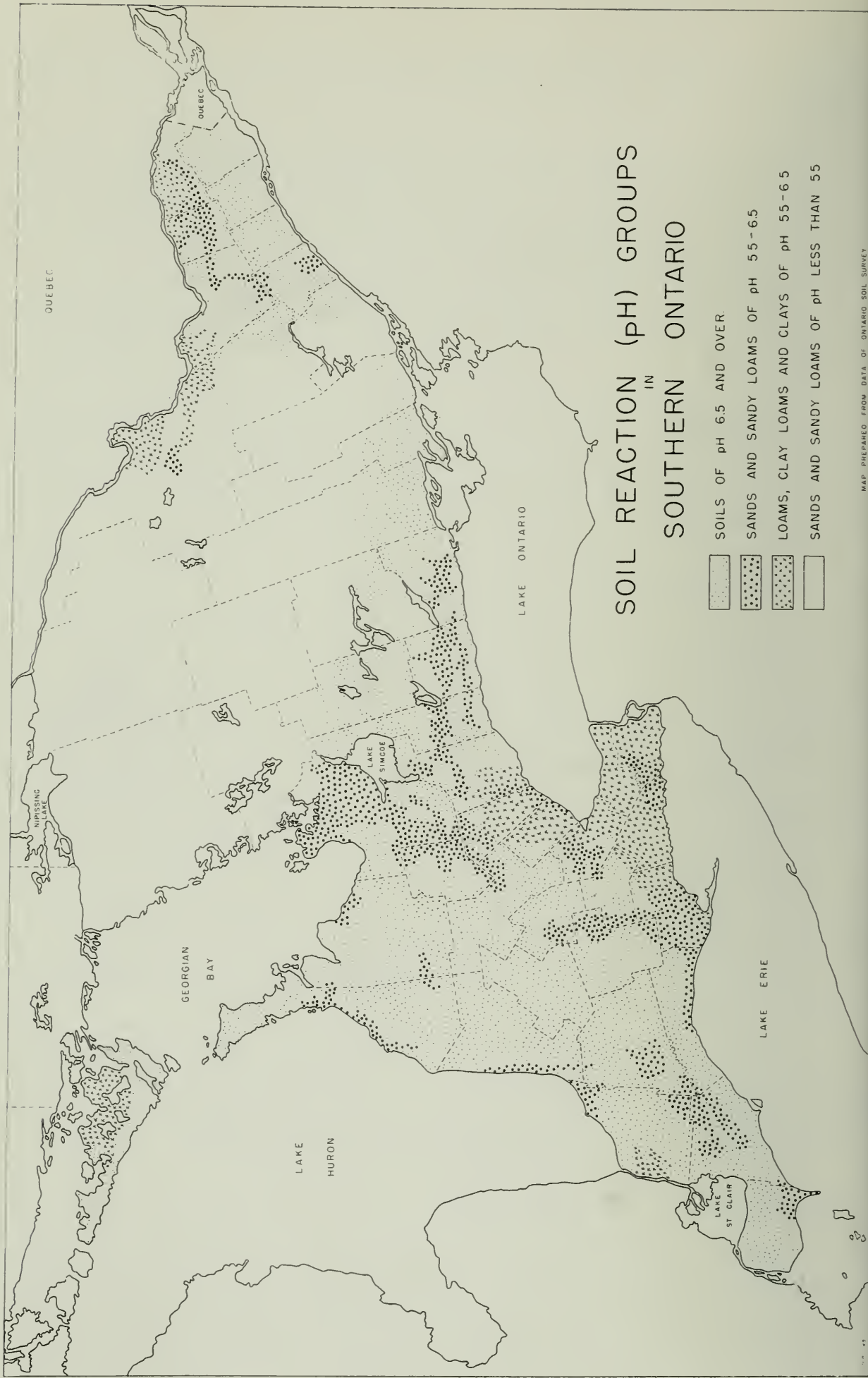
Where do acid soils occur in Ontario?

The map of Southern Ontario shown on page 4 illustrates, in general, the areas where soils are acid and in need of lime.

There are exceptions, however, within any area of land. There may be farms or even fields within the acid areas which do not require lime. Similarly, in the sections of Ontario where the map does not indicate the need of lime, there may be local pockets of acid soils.

How to tell your soil's need of lime

A soil test will indicate if the soil is acid. The Province of Ontario provides a free soil test service for Ontario farmers. Your agricultural representative can supply you with information on soil testing. A few years after lime has been applied, it is always a good practice to send



more samples for testing to see if more lime is needed. The kind of limestone you use, how you put it on, the amount and kind of clay and organic matter in the soil — all are factors in how effective a recommendation from the soil test can be. The best of recommendations and treatments need checking to determine if enough limestone has been used.

Why Use Limestone?

Acid soils are low in calcium and sometimes magnesium as well. Limestone supplies one or both of these elements. Calcitic limestone supplies only calcium. On the other hand, dolomitic limestone contains about 60 per cent calcium carbonate and 40 per cent magnesium carbonate. It is recommended that the cheapest limestone be used, provided it is an approved grade.

Occasionally inquiries are made as to whether calcium chloride or calcium sulphate (gypsum) can be substituted for limestone. Some experimental work has indicated that calcium can be supplied to the soil by calcium chloride or calcium sulphate. Yields according to these data have shown results comparable to limestone treatments. However, it must be pointed out that such treatment, while effective on a few soils, is not generally applicable. Calcium chloride or sulphate does supply calcium but creates conditions for greater acidity. It has been shown by many workers that the correction of acidity is as important as supplying calcium. Indeed, many of our acid soils probably contain sufficient calcium for crop needs, but the acidity is their limiting factor. **Only limestone is capable of correcting acidity and supplying calcium as well**, and limestone is much less costly than calcium chloride or sulphate.

What are the Benefits of Correcting Acidity?

1. If acidity is corrected, a wider range of crops can be used in the rotation. Soil-improving legumes such as alfalfa and clovers, will grow better. This results in nitrogen being added to the soil from the air, and the deep-rooting habits of these crops help to break up impervious subsoils.

2. Most soil micro-organisms thrive in soils near the neutral point. This means better fixation of nitrogen by the legumes. It also means faster release of the plant nutrients which are locked up in the organic matter.

3. All the nutrient elements in the soil are of a chemical nature. Most chemical reactions are influenced by the degree of acidity or alkalinity. At pH values of 6.5 to 7.0, most of the soil compounds bearing mineral nutrients are at their optimum solubility.

- (a) Nitrate release from organic matter is slow in acid soils.

- (b) Phosphate compounds are most readily available to plants when soils are near the neutral point.

(c) Acid soils promote a high degree of solubility of such elements as iron, aluminum, and manganese. While iron and manganese are necessary elements, they are needed only in small amounts. If present in excess of this, they may be poisonous and influence yields adversely.

(d) Soils which are too alkaline (pH 8.0 and above) have reduced solubility of such essentials as boron, manganese, iron, copper, and zinc. If the reduction in solubility is great enough, deficiencies of these elements could occur. Overliming is, therefore, not recommended.

4. An abundance of calcium in a soil is considered to be the first step in the promotion of good soil structure in fine-textured soils (clays). Of equal or greater importance, however, is the growing of sod crops which are the chief structure builders. The growth of good sod crops is promoted by liming.

5. Liming increases the efficiency of fertilizer. Fixation of soluble plant nutrients is more severe in acid soils. If these soils are neutralized, applied fertilizer has a better chance of absorption by plants.

Is Hydrated or Burned Lime Recommended?

These modified forms of limestone are not generally recommended. They are caustic and will burn seedlings. Therefore, if used, they should be applied at least one month in advance of planting. Also they are considerably more expensive than limestone. Their one advantage is their ability to neutralize acid soils in a short time. Use only one-half of the amount of burned lime or two-thirds the amount of hydrated lime that would normally be used when limestone is applied.

Can Marl be Used?

Marl is a white deposit which accumulates in some swamps. Some marls have a high lime content, as much as 90 or 95 per cent, while others contain 50 per cent or more of foreign material, chiefly sand, clay and some organic matter.

When marl is wet, it is sticky, which makes it difficult to apply evenly. When it dries out, the marl becomes lumpy and should be crushed before applying. Often these inconveniences are sufficient to rule out its use, despite its low cost. It is usually feasible to use marl only when the supply is very close to the farm.

Are By-Product Limes Useful?

Various industries use limestone or burned lime in processing their products. Such second-hand limestones may or may not contain toxic elements. Often they are in poor physical condition and difficult to spread evenly. When they are used, it is always safer to apply them several

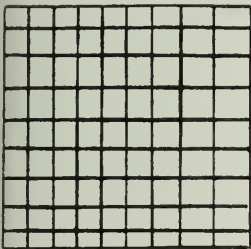
months in advance of planting in order to be sure that toxic elements are leached from or absorbed by the soil. Lime from sugar refineries may be used satisfactorily if it is not too wet or too lumpy.

Buy Only Approved Limestones

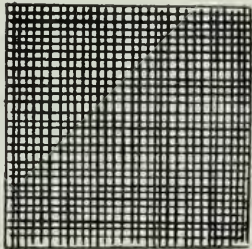
Chemically pure calcium carbonate is assumed to have a neutralizing value of 100 per cent. The neutralizing value of an approved limestone should not be less than 85 per cent. However, it can readily be seen that a 100 per cent pure stone will not be effective in neutralizing soil acidity if the particles are so large that they will not dissolve within a few years' time. All of the particles of an approved agricultural limestone must be fine enough to pass a 10-mesh screen, 50 per cent must pass a 40-mesh screen, and 30 per cent must pass a 100-mesh screen. The mesh size of a screen is determined by the number of wires to the square inch, as illustrated in Diagram 4.

A list of the companies selling approved limestones is available at your agricultural representative's office.

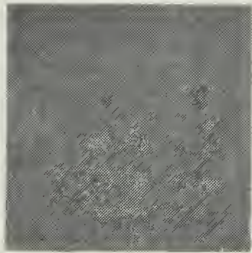
DIAGRAM 4



10-MESH SCREEN
10 wires each way to the inch.
Diameter of each opening is 0.07 inches.
100% of particles must pass.



40-MESH SCREEN
40 wires to the inch.
Diameter of each opening is 0.015 inches.
50% of particles must pass.



100-MESH SCREEN
100 wires to the inch.
Diameter of each opening is 0.006 inches.
30% of particles must pass.

Equipment for Spreading Lime

When limestone is applied, it should be broadcast on the surface of the soil as evenly as possible. This can be done best by either an ordinary farm lime spreader or specially equipped trucks designed for the purpose. Diagram 5 illustrates the equipment. Manure spreaders or grain drills are sometimes used when other equipment is not available.

When a lime spreader is used, bulk lime is dumped at the side of the field and the lime is shovelled into the hopper. If the lime is delivered in bags, the bags are emptied into the hopper.

Either of these methods involves a lot of hard and dirty labour. Lime-spreading trucks will now spread the lime over the field without any hand labour whatever. Your agricultural representative has a list of owners of these trucks. The cost of truck spreading is not much more than the cost of ordinary delivery of lime in piles.

DIAGRAM 5



Truck spreader



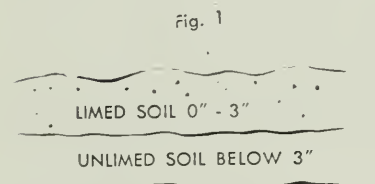
Lime spreader

How Lime Should Be Worked Into the Soil

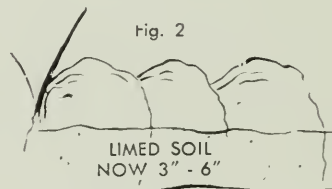
If a soil is acid, the acidity of all the soil to plough depth should be neutralized. This can be accomplished only by mixing the lime and soil together as completely as possible. Because lime dissolves and moves slowly, lime particles neutralize only soil particles close-by. This means that lime top-dressing, without cultivation, is effective in neutralizing only about one inch or less of top soil. Lime is best applied on ploughed land and disked in.

The diagrams below illustrate an effective way to apply limestone. However, in wet periods it may be impossible to drive a truck spreader over a ploughed area. In such cases, the lime is broadcast and the land is then ploughed, but one must be sure the sod is turned on end rather than completely turned over. In the latter case, the lime is merely transferred from the surface to the plough sole, where it will have little effect in assisting the growth of seedlings.

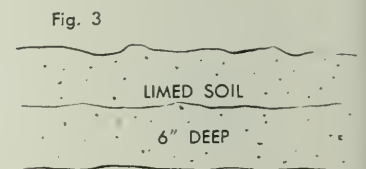
DIAGRAM 6



Lime applied on
ploughed soil and
disked in.



Lime applied and
worked into the soil
as in figure 1. Then
completely turned
over by ploughing
later in a rotation.



A second application
of limestone made to
the ploughed soil in
figure 2 and disked
in.

When Should Limestone Be Applied?

Limestone may be applied at any time of the year and worked into the soil when weather permits. For obvious reasons, it cannot be spread too well on snow. On rolling land, it should not be applied after solid freeze-up time in the fall. The finer lime particles are likely to be washed down the slopes. On such soils, it is better to wait until the snow has melted in the spring and apply the lime on the frozen ground during a spring cold spell. On level land, the limestone may be applied during the winter if the snow cover is not too deep for easy handling of equipment.

How Much Lime Should Be Used?

The amount of lime to use on any particular soil will depend upon the following factors:

1. The pH of the soil. The more acid a soil is, the more lime it will need.

2. The texture of the soil. Coarse textures, such as sandy soils, require less lime than fine-textured or clay soils, pH being equal in both.

3. The organic matter content. Acid soils of the same texture will require more lime if they are high in organic matter than they will when organic matter is low.

4. The crops to be grown. The pH preference scale for various crops is shown on page 2. Legume crops, particularly alfalfa and sweet clover, require more lime than corn and most small grains.

5. The kind of limestone. Fine grades of limestone are faster acting than coarser grades. Dolomitic limestone is harder than calcitic stone and requires a longer time to react. Limestones of low purity must be applied at heavier rates than would be necessary for a high purity stone of the same size. Burned lime and slaked lime are faster acting than limestone, and their rates of application are, respectively, only half and two-thirds of the rate recommended for limestone.

6. If a soil needs lime at all, a **minimum application should be one ton per acre** on sandy soils and two tons per acre on heavier soils. Cost of transportation and application often exceeds the price of limestone, and it is therefore not profitable to use amounts less than this. The only exception is in the case of potato growers. Potato scab is usually less severe in acid soils, and the use of limestone may promote the incidence of scab. Potato growers having difficulty in establishing legumes may use 300 to 400 pounds of limestone per acre mixed with the top inch of soil to promote favourable conditions for starting the clover seedlings. This amount of lime is likely to be used up and thus is not likely to affect soil pH by the time potatoes appear again in the rotation.

TABLE 1
pH Changes Over a Four-Year Period in Haldimand Clay Soil Limed
with Calcitic and Dolomitic Limestones at Different Rates

Treatment		pH of Surface Soil in Designated Years After Application			
Type of Limestone	Rate of Application Tons per acre	1st year	2nd year	3rd year	4th year
No limestone	Check plots	5.4	5.6	5.9	5.5
Dolomitic	2	6.1	6.2	6.3	6.1
Calcitic	2	6.2	6.7	6.2	6.1
Dolomitic	4	6.3	6.4	6.3	6.3
Calcitic	4	6.7	6.8	6.5	6.5
Dolomitic	8	6.5	6.9	6.5	6.5
Calcitic	8	7.0	7.0	6.8	6.9
Dolomitic	12	6.3	6.9	6.6	6.6

TABLE 2
pH Changes at Three Depths Four Years After Various
Limestone Applications on Haldimand Clay Soil.

Treatment		pH of Soil at Depth Indicated		
Type of Limestone	Rate of Application	0-6"	6-9"	9-12"
No limestone	Check plots	5.5	5.5	5.7
Dolomitic	2	6.1	5.7	5.6
Calcitic	2	6.1	5.8	5.8
Dolomitic	4	6.3	5.8	5.9
Calcitic	4	6.5	5.7	5.6
Dolomitic	8	6.5	6.0	6.1
Calcitic	8	6.9	5.9	5.6
Dolomitic	12	6.6	5.9	5.6

Is Very Fine Calcitic Stone Better than Ordinarily Approved Dolomitic Stone?

To answer the above question, an experiment was established at the regional research station near Cayuga on Haldimand clay soil. An approved grade of agricultural limestone of the dolomitic type was compared with a very finely ground calcitic limestone. The dolomitic stone passed all specifications for an approved limestone, with 30 per cent passing a 100-mesh screen and no particles larger than 10-mesh size. The calcitic stone was very fine, 85 per cent passing a 100-mesh screen.

In general, the results shown in Table 1 indicate that calcitic stone is a little faster acting than the dolomitic, but that after a few years the two products were about equal in their ability to correct soil acidity.

Table 2 gives the pH values at various depths down to 12 inches, four years after the limestone was applied. Limestone has raised soil reaction in the surface 6 inches, generally in proportion to the amount used. Even at high rates, the very fine calcitic grade, which dissolves more easily than the coarser dolomitic, has raised pH values only slightly at the 6 to 9-inch depth. This indicates that the calcium in the limestone has not moved downward appreciably in this soil over a four-year period. The importance of proper placement of the limestone is thus emphasized.

Coarser textured soils—sands and sandy loams—may provide conditions for a somewhat faster movement of the calcium in limestone. However, even in these soils, experimental data do not show a rapid movement.

Does Limestone Increase Hay Yields?

The results shown in Table 3 were recorded three years after limestone applications were made. The hay crop was a mixture of alfalfa, alsike, red clover, and grasses. There is a close relationship between the pH value of the soil and the yield of hay. As pH goes up, yield also increases. The growing season in which these data were secured was very hot and dry, which accounts for the relatively low yields. Despite unfavourable conditions, limestone applications had a favourable effect.

TABLE 3
Hay Yield in Relation to Different Limestones Applied at Various Rates to Haldimand Clay Loam

Treatment			Yields ¹ of dry matter Tons/acre
Type of Limestone	Rate of Application Tons/acre	Soil ¹ pH	
No limestone	0	5.4	1.3
Dolomitic ²	2	6.3	1.8
Calcitic ³	2	6.2	1.5
Dolomitic	4	6.3	1.8
Calcitic	4	6.5	1.9
Dolomitic	8	6.5	2.1
Calcitic	8	6.8	2.1

¹Yields of dry matter reported at 3% moisture.
Soil pH and yields are those 3 years after lime applied.
²Dolomitic — agricultural limestone approved grade.
³Calcitic limestone — approved but much finer than the dolomitic.

Assistance on Transportation of Approved Limestone

Rail Shipments

Railways in Ontario co-operate with the Governments of Canada and Ontario in a Freight Assistance Policy on agricultural limestone.

By agreement each year the railways establish a "reduced" rate approximately 25 per cent below the standard tariff for limestone. To this reduced freight the Governments of Canada and Ontario provide freight assistance on the following basis:

Old Ontario

75 per cent of the reduced freight up to a maximum of \$2.50 per ton.

Northern Ontario

75 per cent of the reduced freight.

Truck Shipments

The assistance on truck shipments amounts to 5 cents per ton per mile from the approved source to the farm up to a maximum of \$2.00.

APPLICATION FOR FREIGHT ASSISTANCE

If ordering limestone by carlot, first secure a permit from your agricultural representative and send one copy of this permit with order to the lime company.

On lime trucked direct from an approved source the farmer purchaser should secure from the lime company and the trucker, duplicate invoices for the lime as well as the trucking costs and after delivery secure an "application for assistance" from the agricultural representative. One copy of the application along with duplicate invoices for lime and trucking should be forwarded to Field Crops Branch, Department of Agriculture, Parliament Buildings, Toronto, Ontario.



COMMON GRAIN SMUTS

and THEIR CONTROL

CA20NAF6

B524

GIVES THIS



HEALTHY WHEAT

PREVENTS THIS



BUNT OF WHEAT



Ontario Agricultural College

ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

Dr. C. D. Graham
Deputy Minister

Honourable Wm. A. Goodfellow
Minister

The author is indebted to Prof. D. R. Sands for the use of material taken from the original edition of this bulletin prepared by him in 1951.

I N D E X

	Page
Introduction	3
Common Bunt (Stinking Smut) of Wheat	4
Dwarf Bunt of Winter Wheat	5
Loose Smut of Wheat	9
Loose Smut of Barley	11
Covered Smut of Barley	12
Oat Smuts	13
Corn Smut	14
Seed Treatment	15
I Chemical: Mercury Compounds	15
Other Chemicals	16
Methods of Chemical Treatment	16
II Hot-Water Treatment	23

COMMON GRAIN SMUTS and THEIR CONTROL

by

DR. S. G. FUSHTEY

DEPARTMENT OF BOTANY

ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO

INTRODUCTION

Smut diseases are caused by minute plants known as fungi. Because they contain none of the green chlorophyll which enables green plants to manufacture their own food, fungi depend upon other forms of life to provide the food for them. Many of these fungi go to our cultivated plants for their food and thus reduce the productivity of such plants. The Smut Fungi are among the most destructive of these disease-producing fungi.

The losses in many grain crops due to smut are often much greater than most farmers realize. Before chemical seed treatment practices were generally adopted, it was not uncommon to find fields of wheat with 40 per cent or more bunt in them. This represents a tremendous loss not only in the actual reduction in yield due to the development of smutted instead of healthy heads but also in the reduction of the value of smutted grain for seed or for food. Such badly smutted grain is unfit for normal commercial or seed purposes and is also unfit as feed for livestock. Some animals will absolutely refuse to eat badly smutted grain. Those animals that will eat it may suffer injury if fed it in quantity. Smutted grain is particularly injurious to pregnant, and to very young, animals.

With these risks in mind, it is obviously desirable for a farmer to know something about these diseases and how to control them.



Fig. 1. Common Bunt (Stinking Smut) of wheat.
Two diseased heads on the left. Two healthy heads on the right.
Note the loose or open appearance of the diseased heads.

COMMON BUNT (STINKING SMUT) OF WHEAT

Wheat Bunt may be recognized as soon as the wheat is headed out but is more easily seen as the heads begin to ripen.

Appearance

The diseased heads are usually bluish-green in colour and remain green longer than normal heads. They stand more erect and do not colour so much as the healthy heads do when the grain is ripening. Smutted plants are usually slightly shorter than healthy ones.

In place of good kernels of wheat, dark structures develop which resemble wheat kernels but are usually shorter and thicker, causing the glumes to spread apart. The infected heads thus appear more loose or open than healthy ones (particularly when ripe). When crushed, the dark structures, or "smut balls", are seen to contain a mass of sooty-black powder, the individual particles of which are the "spores" or seed of the fungus. These spores are so small that there are several millions of them in each smut ball. The smut spores have a strongly foetid or fishy odour, hence the name "Stinking Smut". During harvest and threshing many of the smut balls are broken open, and the spores spread to contaminate the good grain from the healthy heads. See Life Cycle, Figure 2.

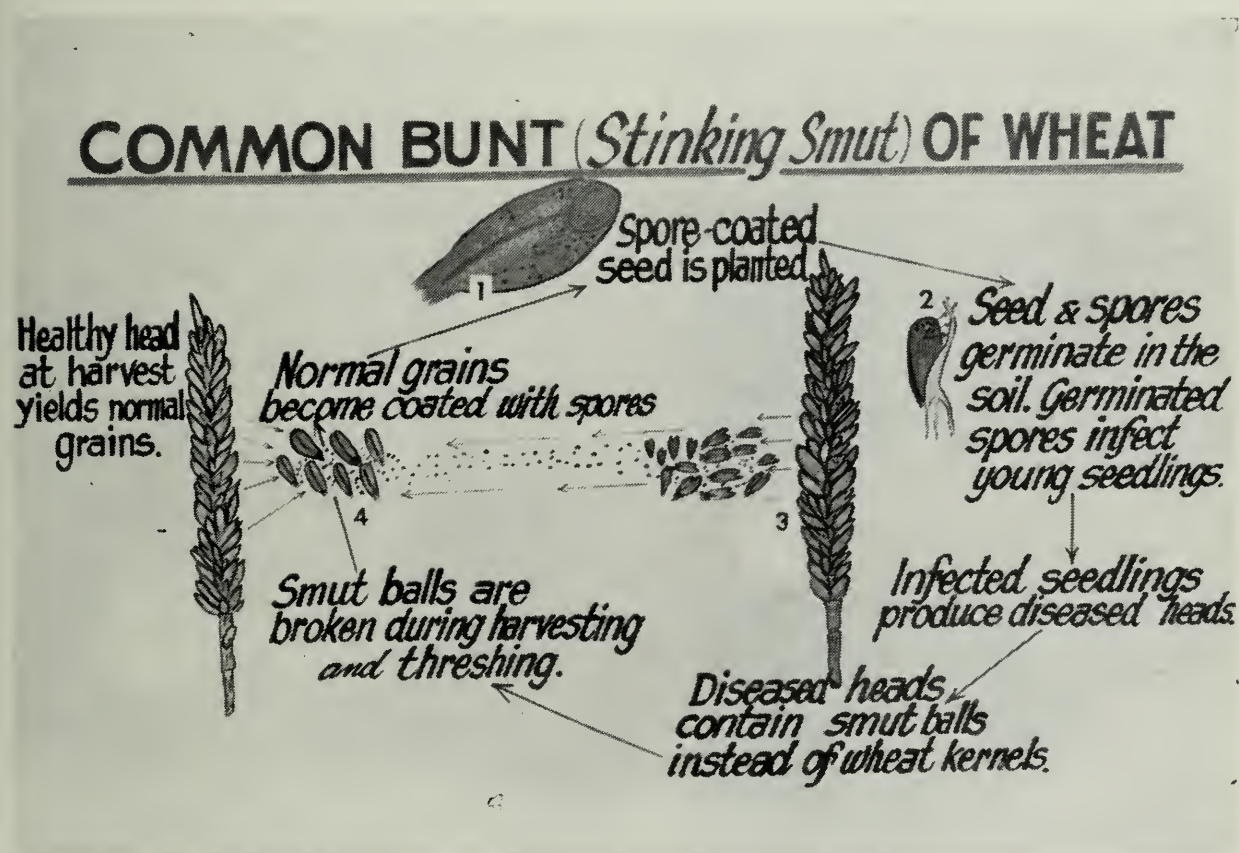


Fig. 2. Life Cycle of Common Bunt of wheat.

Control

The fungus which causes this disease is carried from one year's crop to the next in the form of the spores sticking to the kernels of wheat. Chemical seed treatment which kills these spores will control the disease. See Seed Treatment, page 15.

DWARF BUNT OF WINTER WHEAT

As in Common Bunt, Dwarf Bunt of winter wheat may be recognized as soon as the wheat is headed out or any time between heading and harvesting.



Fig. 3-a. A row of heavily infested wheat showing the dwarfed habit of diseased plants.



Fig. 3-c. Comparison of diseased and healthy heads; immature stage. Left to right—Diseased, healthy, diseased, healthy. Note bluish-green colour of diseased heads as compared to yellow-green of the healthy ones.

WINTER WHEAT

Fig. 3-b. Four infected plants showing both diseased and healthy heads. Note that the diseased heads occur at approximately one half the height of healthy ones.



Fig. 3-d. Comparison of diseased and healthy heads; mature stage. Diseased on the left; healthy on the right. Note golden brown colour of healthy heads as compared to the gray, weathered appearance of diseased ones. The curved nature of the head second from the left is also characteristic of dwarf bunt when the heads are ripe.



Appearance

Diseased heads are similar to those of common bunt, but infected plants are very much shorter than healthy plants (about half the height or less). Diseased plants also tend to tiller excessively.

The stunted or dwarfed character is the main identifying feature in the field. If one finds smutted heads which are as large as healthy ones but which are down in the crop at a level of about one third to one half the average height of the crop, one may be reasonably certain that this is dwarf bunt. However, such diagnosis is not always correct because plants affected with common bunt may occasionally be stunted. The positive diagnosis is a microscopic examination of the spores. If dwarf bunt is suspected, a sample consisting of several smutted heads should be sent to the Department of Botany, Ontario Agricultural College, for identification.

Control

Seed treatment with certain chemicals will kill the spores adhering to the kernels and prevent the spread of the dwarf bunt on the seed. See Seed Treatment, page 15.

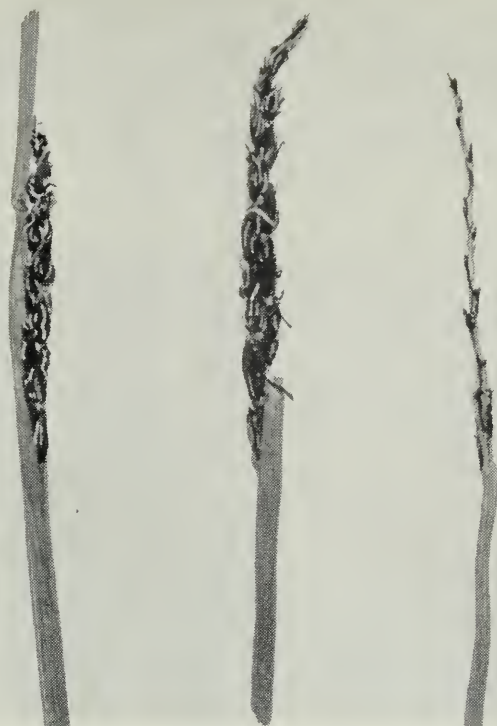
Where dwarf bunt is already present on a farm, there is no effective control method known. The spores persist in the soil for many years and no seed treatment can protect seed planted in such soil.

The following precautions should be taken to prevent introducing the disease into clean soil:

- (1) Buy registered or certified seed. Such seed is carefully inspected, and a certificate is issued only if it is free from dwarf bunt.

- (2) When seed is brought in from outside sources, treat it with one of the chlorobenzene chemical seed dressings.

Fig. 4. Loose Smut of wheat. The two heads on the left show the disease at a stage not long after heading when the spores adhere to the stalk. Later the spores are scattered by wind and rain leaving a bare stalk as shown on the extreme right.



LOOSE SMUT OF WHEAT

Loose Smut of wheat can be seen as soon as the heads begin to emerge. The diseased heads emerge slightly earlier than the healthy ones.

Appearance

A conspicuous black mass appears in place of the healthy head. This black mass is composed of tiny spores that are scattered by wind and rain during the time that the healthy heads are in blossom. The bare stalk is all that remains by the time wheat begins to ripen.

The spores of this smut may be carried for long distances by wind, insect, or other carriers, become lodged in normal wheat flowers, and infect them. These infected flowers then produce kernels which appear perfectly normal but which contain the fungus inside. When planted, such seeds produce smutted heads. See Life Cycle, Figure 5.

Control

Chemical seed treatment is of no value because the fungus is inside the seed and any chemical which will penetrate to kill the fungus will kill the seed also. The only way that such diseased seed can be cleaned up is by the hot water treatment. Otherwise, the best way to avoid loose smut in wheat is to select seed from crops which have not shown the disease. For Hot Water Treatment, see page 23.

Some varieties of wheat are more resistant to loose smut than others. Of the varieties commonly grown in Ontario, Cornell 595 and Genesee are most resistant, Dawbul is fairly resistant, and Dawson's Golden Chaff is susceptible. They are all susceptible to Common Bunt and Dwarf Bunt.

LOOSE SMUT OF WHEAT

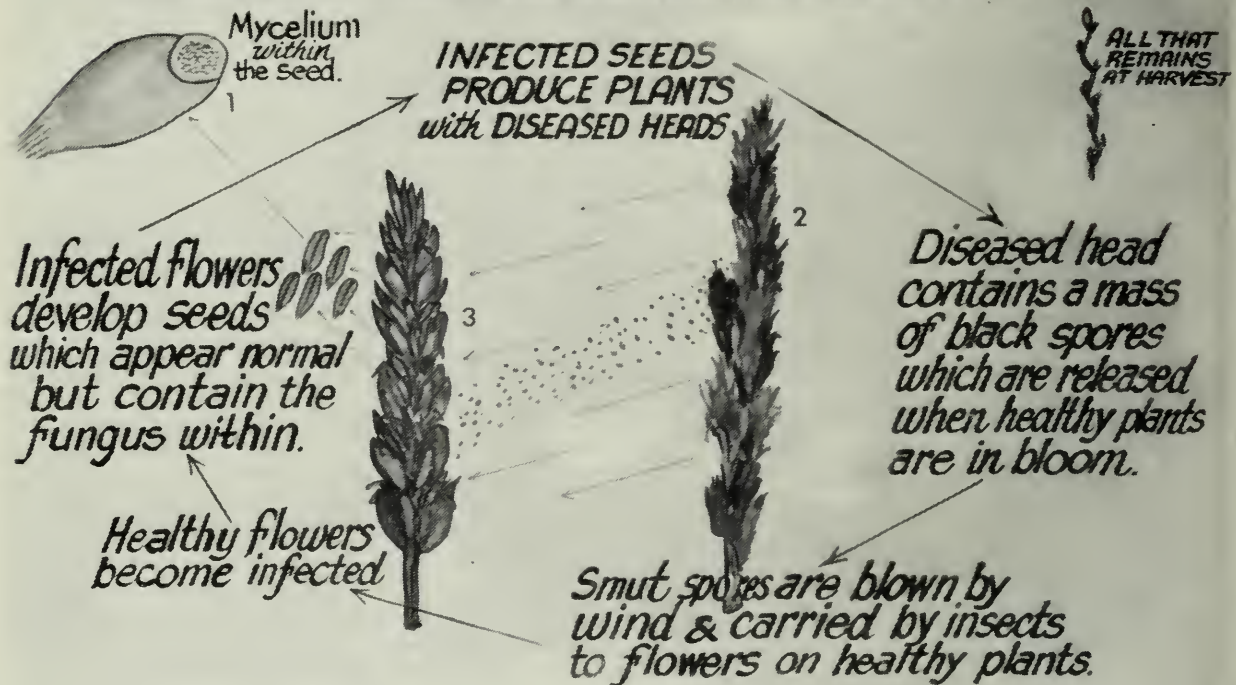


Fig. 5. Life Cycle of Loose Smut of wheat.

LOOSE SMUT OF BARLEY

Loose Smut of barley is first seen as the barley is coming into head and may be recognized up until harvest time. The diseased heads emerge from the boot a little earlier than the healthy heads.



Fig. 6. Loose Smut of barley.
Early stage on the left.
Late stage on the right.

Appearance

A conspicuous sooty brown mass of spores appears in place of a healthy head of barley. At first this mass of spores is enclosed in a silvery membrane. This membrane usually breaks by the time the healthy heads are in blossom; the spores are released and are blown about by the wind or carried by insects to infect the flowers of normal barley plants. By harvest time the winds and rains have removed the dark spore masses, and all that remains of the smutted head is the bare stalk.

Control

As with loose smut of wheat, chemical seed treatment is of no value. The fungus causing this disease is within the grain, and the only method of control is either to select seed from crops which have not shown the disease or to use the hot water method of treating seed given on page 23.

There are no varieties of barley which are resistant to loose smut.

**Fig. 7. Covered Smut
of barley.**

Note that a membrane covers the spore mass holding it in place until harvest.



COVERED SMUT OF BARLEY

Covered Smut of barley can first be seen soon after the barley has headed out. The smutted heads emerge about the same time as the healthy ones and become more conspicuous as the crop reaches maturity.

Appearance

A dark mass of spores has replaced the barley grain. Unlike loose smut, this dark-brown to black mass is enclosed within a grey membrane which usually persists until harvest. During harvesting and threshing operations the spore masses are broken up, and lumps of these dark masses may be seen in the threshed grain.

Control

The fungus causing the disease is carried to the following crop as smut spores on the surface of the grain or under the hull. Chemical seed treatment will kill these spores and control the disease. See page 15.



Fig. 8. Smut of oats.
Covered smut on the
left.
Loose smut on the
right.

OAT SMUTS

There are two smuts of oats: Covered Smut and Loose Smut, which look much alike in the field. Both of them may be seen when the oats head out, and some smut remains until harvest. In some varieties of oats, covered smut may not be conspicuous until the crop is mature.

Appearance

When the oats head out, masses of black spores have replaced the oat grains and sometimes the chaff also. These spores are contained within a thin membrane. In the loose smut the membrane soon breaks and the smut spores are scattered, leaving a more or less naked panicle. In the covered smut the membrane is more persistent and may remain until the grain is harvested. The persistence of the membrane and the extent of damage to the panicle vary with different varieties of oats.

Control

The fungi causing loose and covered smut in oats are carried to the following crop as smut spores on the surface of the grain or under the hull. Chemical seed treatment will kill these spores and control both of these smuts. Seed Treatment, page 15.

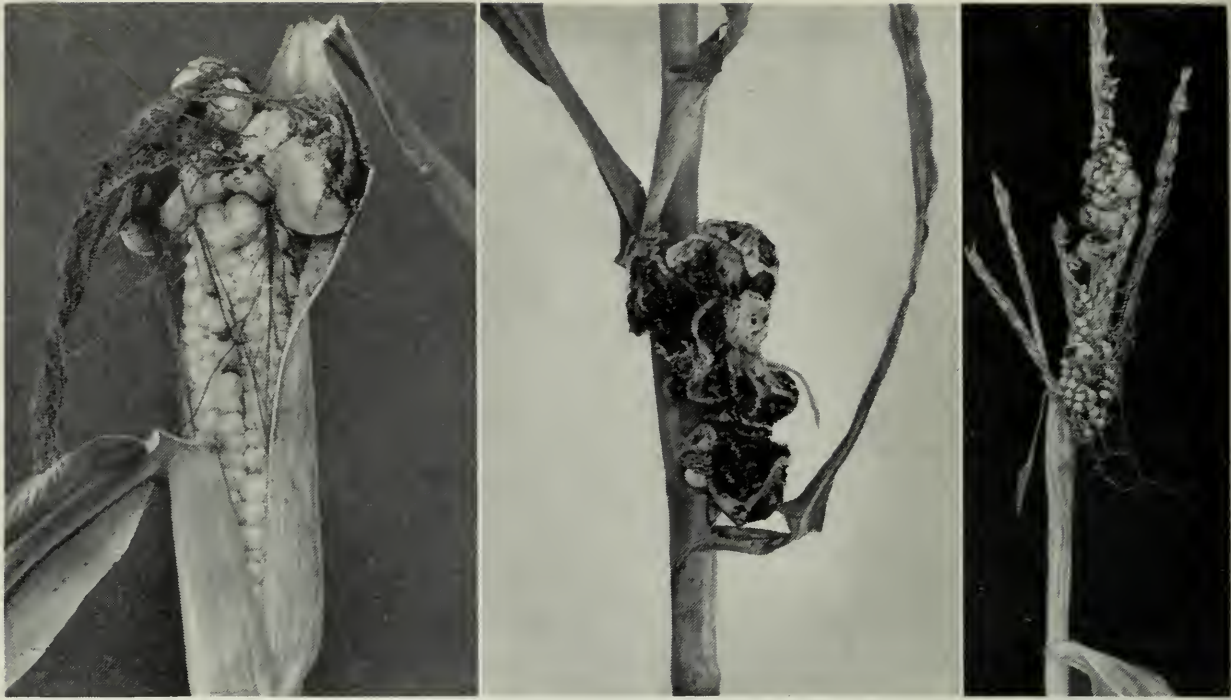


Fig. 9. Corn Smut. Left to right: On cob, stem, and tassel.

CORN SMUT

Any tender part of the corn plant may be affected during the growing season. Smut is usually seen from the mid-growing period until harvest time. Late infections may occur where the plant has been injured.

Appearance

It develops as conspicuous galls, often called “smut boils”, on stems, leaves, cobs, and tassels. In early stages the “smut boils” are light-coloured and covered with a thin grey membrane. This membrane soon develops a polished or silvery lustre. Later the interior of the “smut boils” becomes black. Finally the membrane breaks and a powdery black mass of spores is scattered by the wind and rain.

Control

There is no satisfactory method of control. It cannot be controlled by seed treatment because the spores of the fungus live over the winter in the soil or on crop refuse. A four-year crop rotation seems to be of some value. In an isolated garden, it is advisable to remove and burn the “smut boils” as soon as they develop. Seed corn is often treated before planting with chemicals such as Arasan S.F., but this is to control or check other diseases.

Some of the newer corn hybrids are moderately resistant to corn smut.

SEED TREATMENT

Common Bunt (Stinking Smut) of Wheat, Covered Smut of Barley, and the Oat Smuts can all be controlled by chemical seed treatment. A number of **mercury compounds** recommended for this purpose are manufactured under a variety of trade names. In addition to controlling smut, these materials improve crop stands by giving protection against a number of seedling blight and seed rot diseases.

For protection against Dwarf Bunt of Winter Wheat, the use of **chlorobenzene** seed dressings is recommended. It is important to note that such treatment will not protect the crop from dwarf bunt spores already present in the soil but will kill the spores on the seed and so help to prevent the introduction of the disease into clean soil. The chlorobenzenes are also effective against Common Bunt of Wheat but do not control smut on oats and barley.

A complete list of cereal seed treatment chemicals is found in the Ontario Department of Agriculture Circular 252, entitled "Chemical Seed Treatment of Cereal Grains".

For control of Loose Smut of Wheat and Loose Smut of Barley, the "**Hot Water**" method of treatment may be used. See page 23.

I. CHEMICAL SEED TREATMENT

i. Mercury Compounds

Organic mercury compounds occupy first place among chemical seed treatment materials recommended for small grain crops. They are so highly rated because they not only control the surface-borne smuts but also improve stands by controlling a number of seedling blight and seed rot diseases.

All mercury compounds are poisonous and must be handled with care. Some of the precautions usually noted on the product label are as follows:

1. Avoid dust or fumes from these chemicals. When treating seed, wear a dust filter and fume mask over the nose and mouth. Where possible, treat seed outdoors. When treating indoors, make sure that the building is well ventilated.

2. Avoid contact with skin or eyes. In case of contact with the skin, wash immediately with plenty of soap and water. For eyes, flush with water for 15 minutes and get medical attention.

3. Never use treated seed for feed. Mixing treated seed with clean seed does not reduce the poisonous character of the chemical. The poisonous mercury is stored up in the animal body, and even extremely small doses consumed in a feed grain mixture will accumulate over a period of time and may eventually prove fatal.

4. Bags and other containers used for treated seed should be thoroughly cleaned before being used for other purposes.

II. OTHER CHEMICALS

The **chlorobenzenes** are a group of chemicals which are recommended for the control of common bunt in wheat, and recently were found to be useful for treating winter wheat seed to prevent the spread of dwarf bunt. They will not control smut in oats or barley and do not give any protection against the seedling blights and seed rot diseases. However, because chlorobenzene seed dressing materials are not considered as poisons, they can be handled without the extreme precautions required for handling the mercurials. Seed treated with these materials is not known to be injurious to livestock, but the feeding of grain treated with any kind of pesticide chemical is a dangerous practice.

Formaldehyde, commercially known as Formalin, is one of the oldest known treatments and has been used extensively in the past. It is still being used occasionally but is generally discouraged because better materials are available. Formaldehyde treatment does not protect the seed from the soil-borne fungi and it is often injurious to the seed. Where better materials are not obtainable, formaldehyde may be used to control smuts in oats. Other grains suffer too much germination injury. See page 18 for directions.

METHODS OF TREATMENT

Seed treatment chemicals are available in three different forms:

1. **Dusts**, which are applied in the dry form.
2. **Wettable Powders**, which may be applied as dry dusts or may be mixed with a small quantity of water and applied as a thin paste known as a slurry.
3. **Liquids**.

The methods used for treating seed will vary according to the amount of grain to be treated.

- a. Small quantities may be treated on the farm with comparatively simple and inexpensive equipment.
- b. For large quantities, large-scale commercial treating machines can be employed.

Farm Treating

For treating seed on the farm there are two types of treaters generally recommended, both of which can be made at home:



Fig. 10. Home-made Seed Grain Duster developed at the University of Minnesota.

(1) **The Seed Grain Duster.** (See Figure 10). Plans for the construction of this treater are available in the circular entitled "Home-Made Seed Treater" prepared by the Crops, Seeds, and Weeds Branch of the Ontario Department of Agriculture. This treater is adapted for use with the dry dust chemicals only. It is extremely important that directions for its operation be carefully followed in order that the chemical be properly mixed with grain.

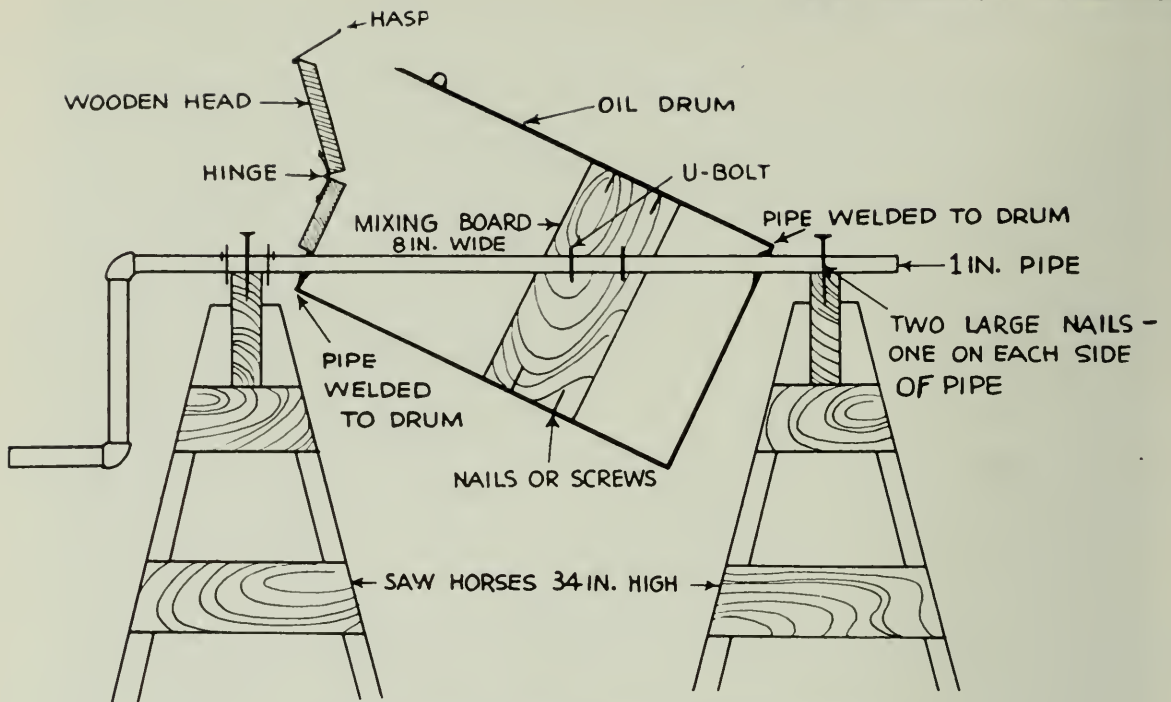


Fig. 11. Home-made Rotary Oil-Drum Mixer.
This type of treater originated at the Pennsylvania State College.

(2) **Rotary Barrel or Oil-Drum Mixer**—(See Figure 11.) This type of mixer can be used for dry dusts, wettable powders in slurry form or liquid chemicals. It is a very efficient type of treater because the amount of mixing can be regulated as required. For example, a drum or barrel of about 30 gallons' capacity will treat one bushel of grain at a time. The measured amount of grain is put into the drum, the exact amount of chemical added, and the drum rotated until the grain and chemical are thoroughly mixed. It is considered that for the dust or slurry treatment the drum should be rotated slowly about 20 times per batch in order to obtain proper mixing. With liquid chemical, a steel drum is preferable to a wooden barrel, the liquid should be added onto the inside wall of the drum rather than onto the grain, mixing should begin immediately the chemical is added, and the number of rotations should be at least twice that used for dusts.

(3) **Formaldehyde treatment**—One pint of commercial formalin will treat 50 bushels of oats. The treatment should be done on a clean floor and in good air circulation because formalin fumes are very irritating to eyes, nose, and throat.

The recommended procedure is as follows: One pint of formalin is mixed with one pint of water. By means of a jar sprayer, an area of the floor beside the grain to be treated is sprayed with the formalin solution. As one man shovels the grain into a pile on the sprayed part of the floor, another sprays formalin on each shovelful, being careful to hold the sprayer close to the grain. When finished, the pile is covered with bags, canvas, or other covering material which first has been sprayed with formalin on both sides.

The grain is then left covered for four to eight hours, or overnight, before being sown. Seed treated with formalin should be planted within one week after being treated. Longer storage may seriously reduce germination.

Commercial Treating

Where large quantities of grain are to be treated different machines are available for use with the different forms of the chemicals.

- (1) **For Dusts**—Use a dust-type treater such as:
 1. The Kemp Seed Treater. (Figure 12.)
 2. The Gustafson Model H Seed Treater. (Figure 13.)
- (2) **For Wettable Powders**—Use a slurry type of treater such as:
 1. Gustafson's Slurry Seed Treater. (Figure 14.)
 2. Calkins Slurry Seed Treater. (Figure 15.)
- (3) **For Liquids**—Use a liquid-type of treater such as:
 1. Panogen Treater. (Figure 16.)
 2. Gustafson's Mistomatic. (Figure 17.)



Fig. 12. Kemp Seed Treater.

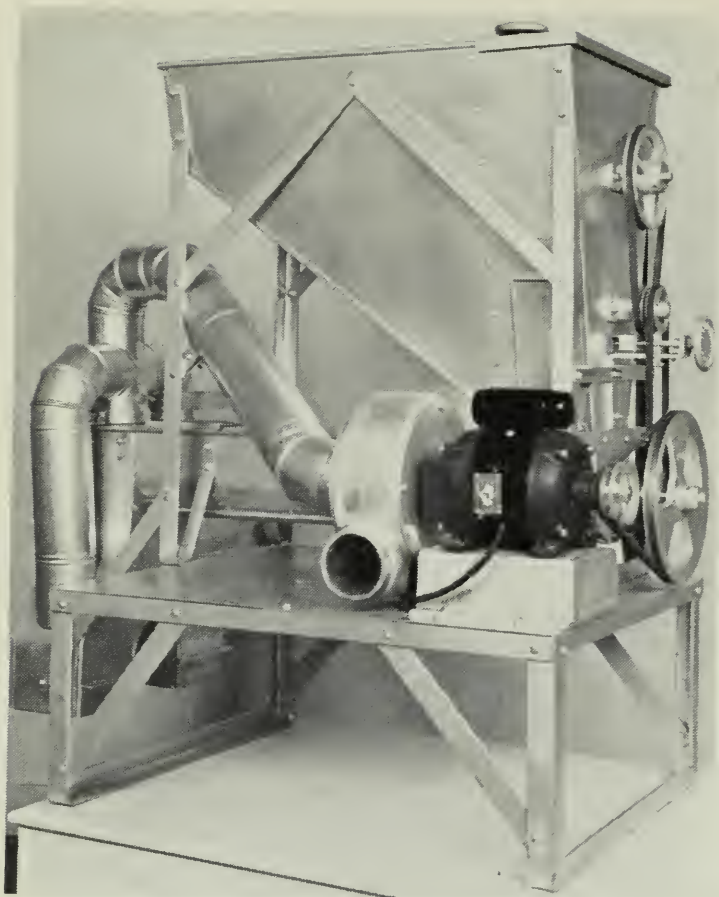


Fig. 13. Gustafson Model H Seed Treater.

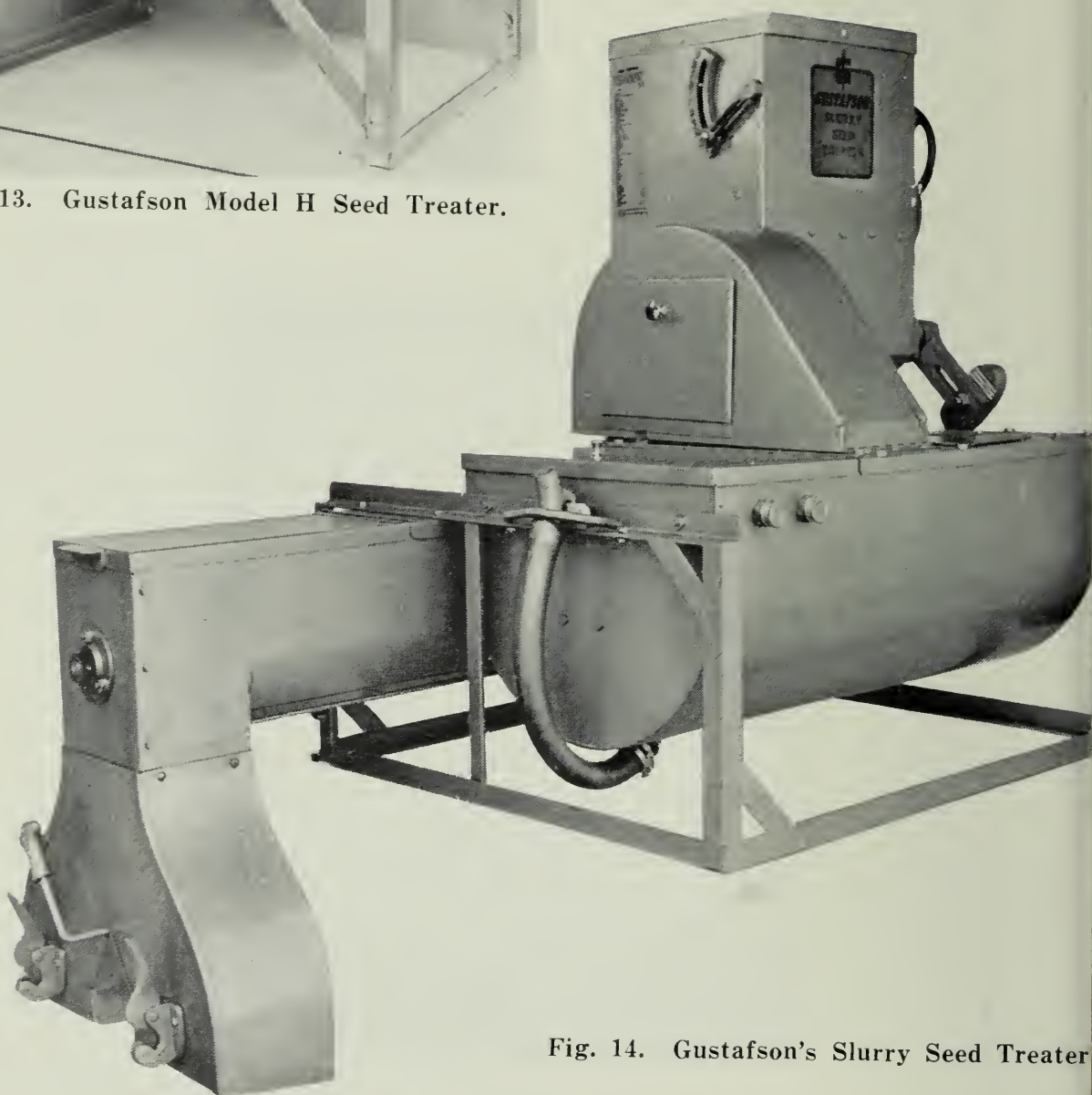


Fig. 14. Gustafson's Slurry Seed Treater

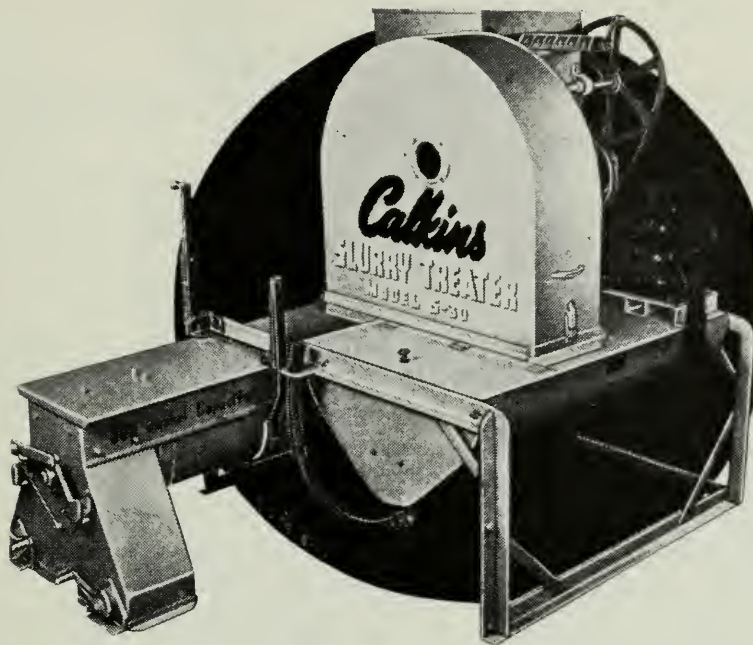


Fig. 15. Calkins Slurry Seed Treater

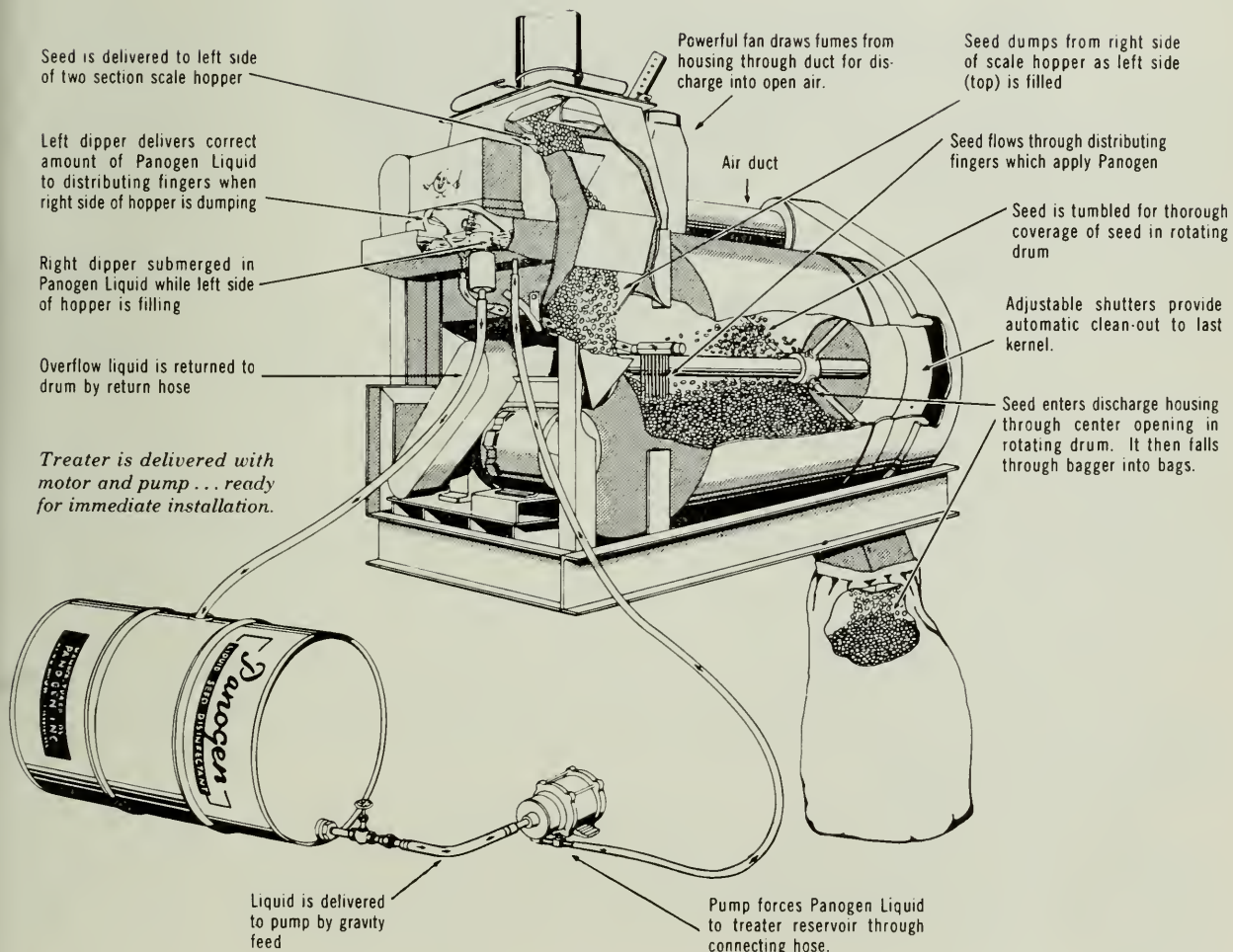


Fig. 16. Panogen Treater.

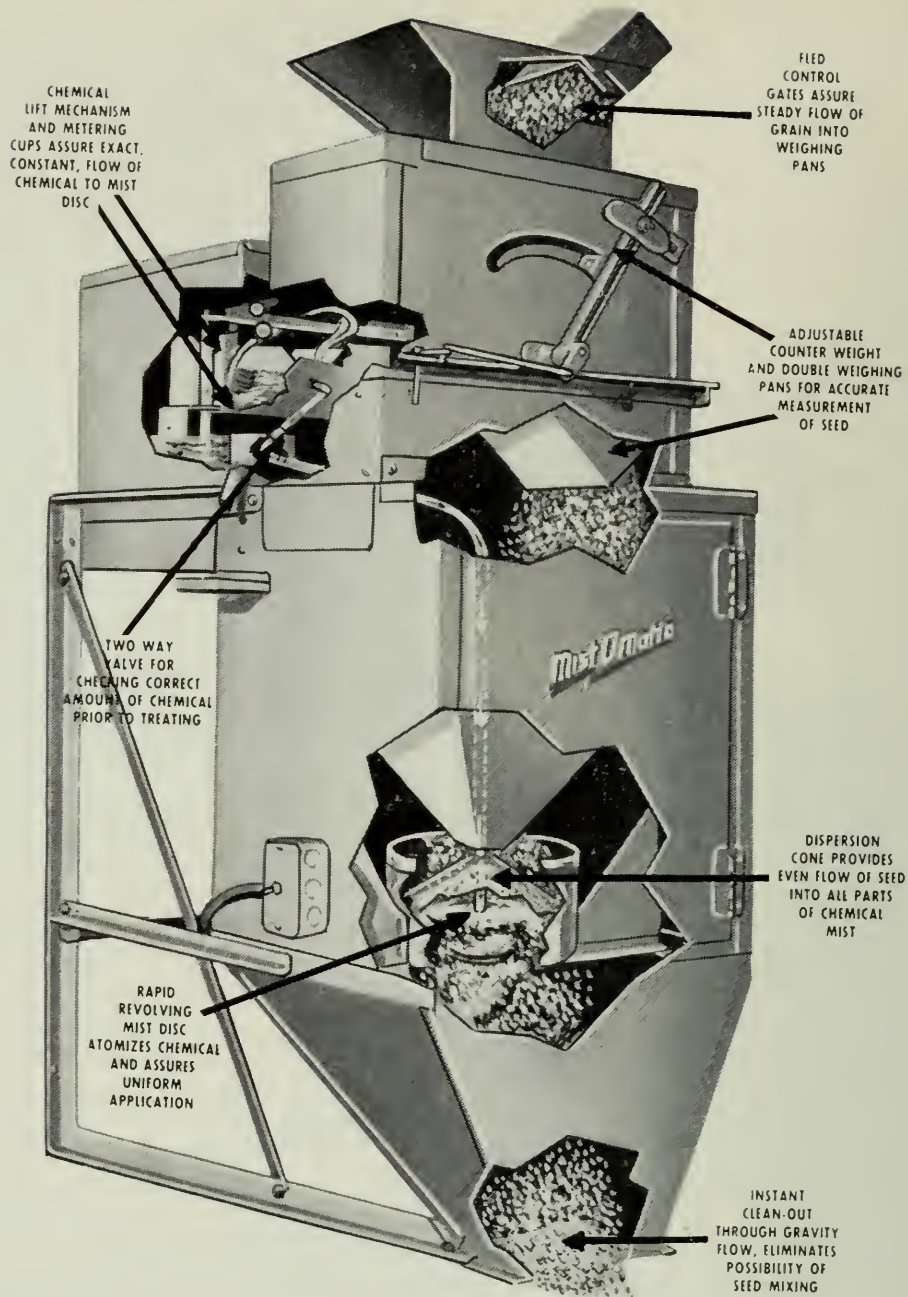


Fig. 17. Gustafson's Mistomatic.

These machines have been proven to do a satisfactory job of treating provided that they are properly operated. The manufacturer's instructions for their operation and care must be carefully followed. Two items that should receive particular attention are:

(1) That the machine is properly calibrated and is delivering the proper amount of chemical for the grain that is being treated. This involves daily cleaning of the delivery mechanism, also frequent checking of the dosage settings.

(2) That the machine is operating within its rated capacity. If operated above rated capacity, the machine can usually be adjusted to deliver adequate chemical for the increased volume of seed, but mixing will be incomplete and the usefulness of the treatment considerably reduced.

II. HOT WATER TREATMENT

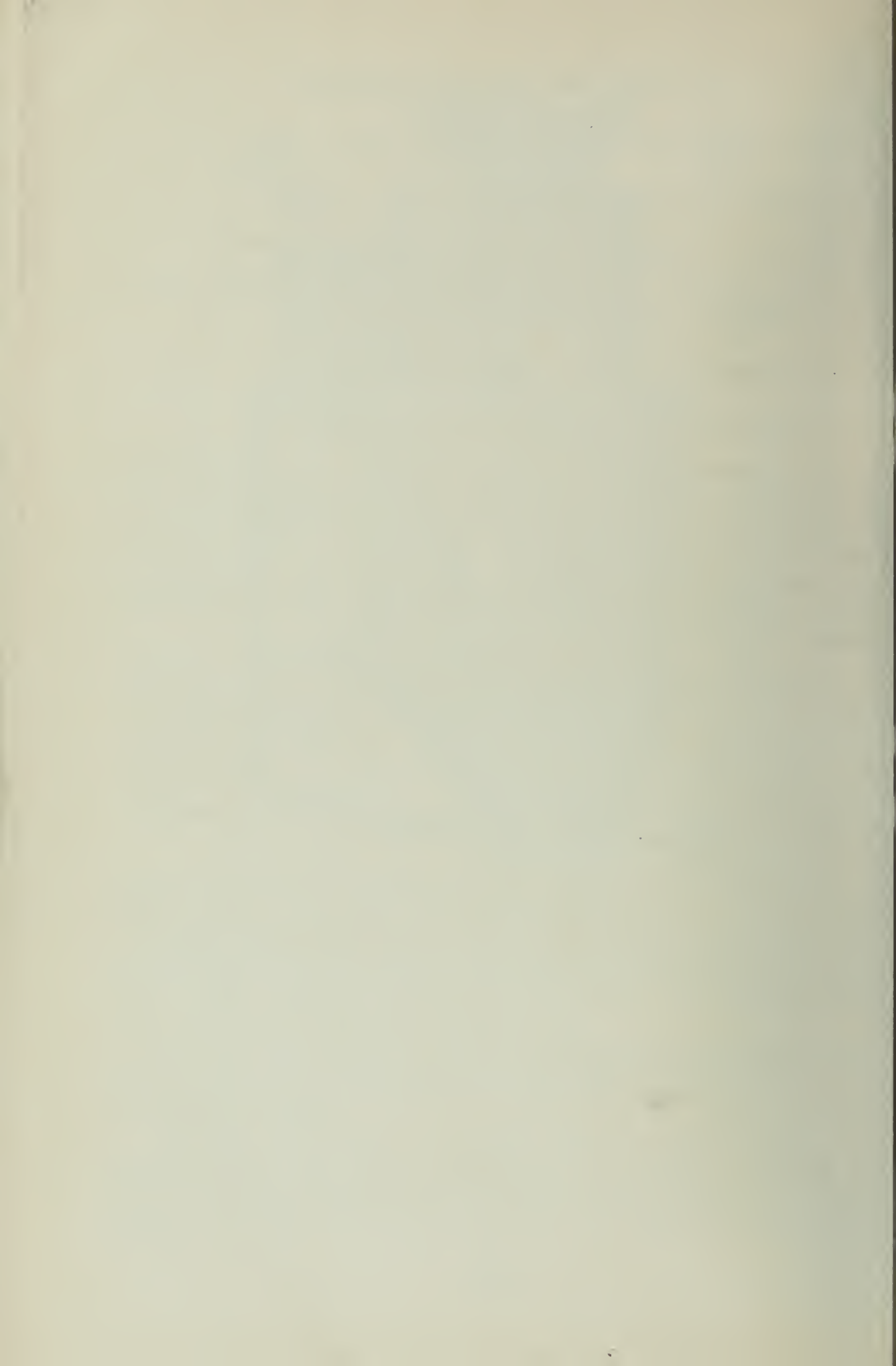
The procedure consists of the following steps:

1. Soak in cool water (about 70°F.) for 4 to 5 hours.
2. Warm by dipping in water @ 120°F. for 2 to 3 minutes.
3. Follow immediately by soaking in hot water (128°F. for 10 minutes.
4. Cool rapidly by plunging in cold water.
5. Drain and spread out to dry quickly.

It is extremely important that the soaking period and temperature of the water be carefully controlled. Too high a temperature or too long a soaking period in the hot water will injure the seed, while too low a temperature or too short a soaking period will not control the smut. Also, the seed should be handled in small lots, about ½ bushel each, in order for the entire bulk of seed to be brought to the required temperature rapidly.

One method of carrying out this procedure is to measure ½-bushel lots of seed into coarse burlap bags and place these to soak in some large container of cool water, making sure that the water is deep enough to cover all the bags. After the desired soaking period in this cool water, the bags are removed and put through the hot water treatment schedule as given in steps 2 to 5 above. This schedule requires three containers of water: one at 120°F., one at 128°F., and one with cold water.

Seed treated in this manner should be planted in a seed plot located as far away as possible from other fields of the same kind of grain. Unless this is done, spores from smutted heads in nearby fields will be blown into the seed plot and destroy any benefit that might have been gained by the treatment.



NOVEMBER, 1957

BOVINE

CARONAF6
B525

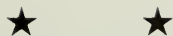
MASTITIS

Hon. W. A. GOODFELLOW *Minister*

Dr. C. D. GRAHAM *Deputy Minister*

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA





BOVINE MASTITIS

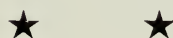
by

F. H. S. NEWBOULD

and

D. A. BARNUM

ONTARIO VETERINARY COLLEGE



Ontario Department of Agriculture

TABLE OF CONTENTS

INTRODUCTION

ECONOMIC IMPORTANCE

Page

Loss in Milk Production	5
Loss from Sale of Infected Cows	5
Cost of Treatment	5
Miscellaneous Factors.....	5
Summary	6

THE NATURE OF THE DISEASE

Non-specific Mastitis	6
Infectious Mastitis	6
a. Acute	7
b. Chronic	8

MICROORGANISMS CAUSING MASTITIS

<i>Streptococcus agalactiae</i>	8
Streptococci other than <i>Str. agalactiae</i>	8
<i>Staphylococcus aureus</i>	8
Miscellaneous microorganisms	9

DIAGNOSIS

Physical Examination of the Udder	10
Physical Examination of the Milk	11
Chemical and Bacteriological Tests on the Milk	11
a. Field Tests	11
b. Laboratory Tests	14
Taking Samples for Laboratory Examination	15
Summary	16

TREATMENT

Symptomatic Treatment	17
Specific Treatment	17
Therapeutic Agents and their Administration	18
a. Antibiotics	19
b. Sulphonamides	19
c. Administration of Treatment	19
Immunization	19

MANAGEMENT OF THE MILKING HERD

Protection of the Udder	21
a. Stable Construction	21
b. Correct Milking	21
c. Feeding	22
d. Breeding	23

(Index Continued)

	Page
Prevention of Spread of Infection	23
a. Protection of Uninfected Cows	24
Bedding	24
Udder cloths	24
Teat Cups, dipping and storage	25
Disinfection of hands	25
Calves	28
Flies	28
Barnyards, lanes, and fields	29
New additions to herd	29
b. Removing, Killing, and Preventing	
Multiplication of Microorganisms on	
Cow's Teats	30
Udder washing	30
Teat dipping	31

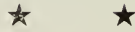
MASTITIS AND PUBLIC HEALTH

Number of Organisms in Milk	32
Leucocytes in Milk	33
Importance of Specific Infections	33
Antibiotics in Milk	34

DISINFECTANTS

Sodium Hydroxide	37
Sodium Hypochlorite	37
Quaternary Ammonium Compounds	38
Iodine	38
Hibitane	39

BOVINE MASTITIS



INTRODUCTION

There are few dairy farmers in Ontario who have not had experience with mastitis in their milking herds. Over the years mastitis has increased despite attempts to control it, and today there is no doubt that this disease is the most widespread scourge of dairy cattle. Mastitis is inflammation of the mammary gland, and may occur in a variety of forms in practically all lactating mammals. It is of particular significance in the dairy cow, since either temporary or permanent damage may result to the udder, economically the most important feature of the cow.

Effective control of bovine mastitis lies in proper diagnosis, effective treatment and elimination of those factors which predispose the animal to this disease. Mastitis control, unlike Tuberculosis or Brucellosis, is and always will be a continuous management problem since organisms capable of causing mastitis are universally widespread. This program calls for thorough understanding of the disease by all those concerned with it, and the aim of this bulletin is to provide that understanding.

ECONOMIC IMPORTANCE

Ontario's dairy farmers might well ask, "How much does mastitis cost us each year?" Annual losses from this disease are known to be enormous. Although a definite figure in dollars and cents cannot be given, an idea of the economic loss caused can be gained from the following brief review of some of the factors concerned.

Loss in Milk Production

Moderate to severe infections in the udder invariably result in some degree of tissue damage and, when this happens, reduced milk yield follows. Research has shown that approximately 20 percent of the lactation yield is lost on the average through this cause. Consequently, it can be estimated that in a herd with 35-40 percent of the cows infected, the loss will be almost 10 percent of the total herd yield. When one considers that 60, 70 and even 80 percent infection in milking herds is quite common, it is not difficult to estimate the over-all loss in milk production.

Loss from Sale of Infected Cows

Every year dairy farmers dispose of many cows for other than dairy purposes because they are no longer desirable members of the milking herd. It is not certain how many of these cows are sold because they are infected with mastitis but figures published by the Ontario Dairy Herd Improvement Association provide an estimate. In 1953, of all cows removed from herds in these associations in Ontario, 10.5 percent left because of udder trouble, and a further 23.4 percent for low production; in 1954 these figures were 12.2 percent for udder trouble and 23.0 percent for low production. It is probably fair to say that a considerable proportion of the low producers were low producers because of subclinical or chronic mastitis.

Cost of Treatment

In Canada, the cost for antibiotics alone for the treatment of mastitis is estimated at more than \$1,000,000 a year.

Miscellaneous Factors

In addition to the losses discussed above there are others which are not so easily estimated and which could be termed hidden losses. In practice these losses may be the most real. In many herds, because some of the animals have mastitis, 5 cows are being milked and fed when 4 disease-free cows could do the same production job. More roughage must be grown; more concentrates bought; and more labour is required for growing crops, doing barn chores and milking. All these factors mean money—money which could be saved, or used elsewhere, or which might be realized if the extra time, space and energy were used for some other income crop.

Summary

All these factors—economic losses, cost of treatment, unproductive labour—constitute a large annual loss to the dairy industry. In the United States the estimated annual loss from mastitis is as high as \$250,000,000. Comparing the number of cows in the U.S.A. with the number of cows in Canada and allowing for a higher value per cow and pound of milk in the U.S.A., Canada's annual loss would total approximately \$25,000,000. Ontario's total, on the same basis, might reach 8 to 9 million dollars.

THE NATURE OF THE DISEASE

Mastitis is an inflammation of the udder resulting from any cause. Consequently there are as many forms or classes as there are causes. Mastitis is not a single entity. Whatever its cause, mastitis results in changes in the tissues of the udder as well as in the milk secreted. These changes vary in severity depending upon the type and duration of the mastitis.

Mastitis can be non-specific, that is, no microorganisms are found in the milk or tissues; or, as is more usual, it can be infectious, that is, a microorganism is found associated with the condition, and can usually be isolated from the milk secreted by the infected quarter.

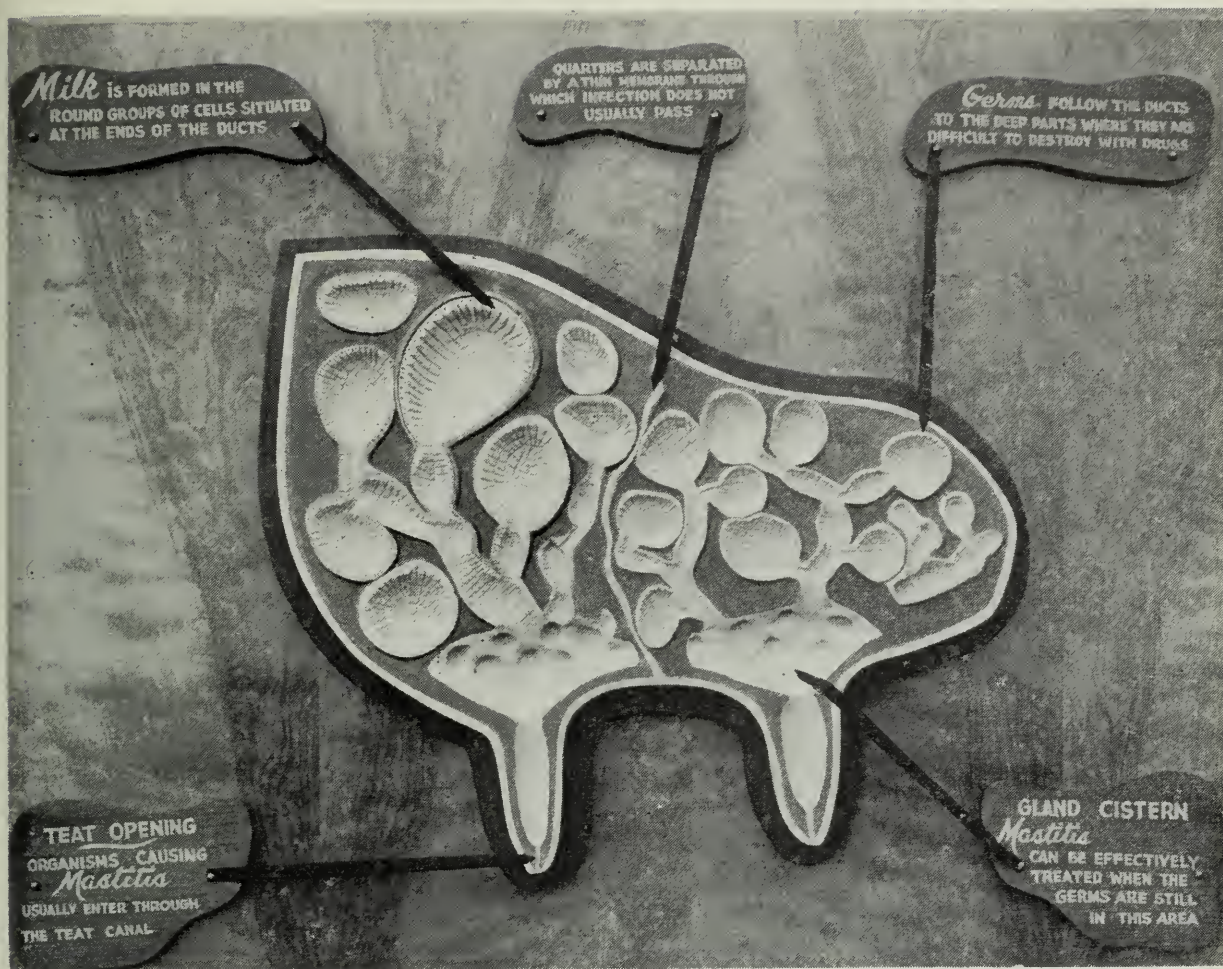
Non-specific Mastitis

This type of mastitis may be caused by irritation, trauma or injury, abnormal temperatures such as chilling, or by any similar condition. Usually such mastitis will clear up on removal of the causal factor, provided that the udder is not invaded by microorganisms which take advantage of the abnormal condition to multiply and prolong the attack. On the other hand a number of non-specific cases arise from unknown causes, are long lasting, and may even become progressively worse, finally resulting in complete loss of the affected quarter.

Infectious Mastitis

Infectious mastitis, as its name implies, is caused by microorganisms which invade the udder and which, under suitable circumstances, may be spread from one cow to others in the herd. Microorganisms invade the udder through the teat orifice and streak canal. They may then become established and may multiply in the milk cistern causing inflammation. From the cistern they spread to other parts of the quarter.

Invasion and establishment of organisms in the udder are followed closely by physical and chemical changes in the milk. Physically the milk may contain clots, become stringy, or watery. Chemically the most apparent changes are decreases in fat, solids-not-fat, casein, lactose, ash and titratable acidity and increases in the water, non-casein nitrogen and chloride. The milk-secreting tissues of the gland are gradually replaced



Schematic diagram of the bovine udder.

by hard areas or induration of non-secreting, fibrous scar tissue. Because there is no communication between the milk-collecting systems of the four quarters, it is possible for infection to remain confined to one quarter.

Infectious mastitis may be roughly divided into two main classes (1) Acute Mastitis and (2) Chronic Mastitis. Infections of varying degrees of severity, and infections caused by many kinds of bacteria are included within these two classes.

(a) **Acute**—Acute mastitis, as its name implies, is very severe inflammation of one or more quarters. It can be recognised readily because the udder is hot, swollen or caked, and very painful to the touch. Owing to congestion at the base of the teat, the affected quarter may show pink discolouration which, in extreme cases, may darken to a red or purple. This extreme condition may be followed by gangrene in which case the udder feels cold to the touch. Milk secretion is usually scant, often watery, stringy or bloody and is sometimes only a thick, foul-smelling discharge.

The microorganisms may remain localized in the udder, but on occasion they may pass into the blood stream bringing about a generalized systemic infection or blood poisoning. In the latter case the cow usually has chills and fever, eats little or not at all, is weak, and may be unable

to stand. Unless treated, such cows may die within a few days. Very severely affected quarters frequently become no longer serviceable, dry up and become "blind".

(b) **Chronic**—Chronic mastitis is a mild, continuous inflammation of the udder. This type of mastitis constitutes about 90 percent of the udder infections commonly encountered. Occasionally a "flare-up" occurs, when the quarter is swollen and production is down. Such a "flare-up" may recede after a few days only to reappear later.

In many cases chronic mastitis is not difficult to diagnose. The milk is abnormal, and small pin-point flakes and clots can be observed on the strip cup. The milk is often slow filtering and the filter pad has to be replaced frequently. There is more or less thickening of the quarter and, consequently, a drop in production results. The diseased tissue is gradually replaced by scar tissue which is incapable of secreting milk. In some cases, very mild infection occurs which cannot be diagnosed by visible symptoms: thus in these cases field and laboratory tests are necessary to determine the presence of infection.

MICROORGANISMS CAUSING MASTITIS

Streptococcus agalactiae

This organism is responsible for a very large percentage of cases of infectious mastitis although, in certain areas, other organisms are becoming more important. While acute cases do occur, *Str. agalactiae* mastitis is usually of the chronic type. It is possible for infection to be present for weeks or months before clinical symptoms are seen, and cows thus affected are of course potential sources of infection to others. The bovine udder is the natural habitat of this organism, and when it is isolated from other sources one may conclude that it originated in infected milk.

Control of *Str. agalactiae* should be based on detection and isolation of infected animals, the use of sanitary and management practices designed to reduce spread of infection, and elimination of the source of infection by treating or selling affected animals.

Streptococci other than *Str. agalactiae*

A number of other streptococci, such as *Str. dysgalactiae* and *Str. uberis*, are known to cause mastitis. While a few cases of mastitis caused by these organisms are reported occasionally in Ontario they are definitely of minor importance in this province.

Staphylococcus aureus

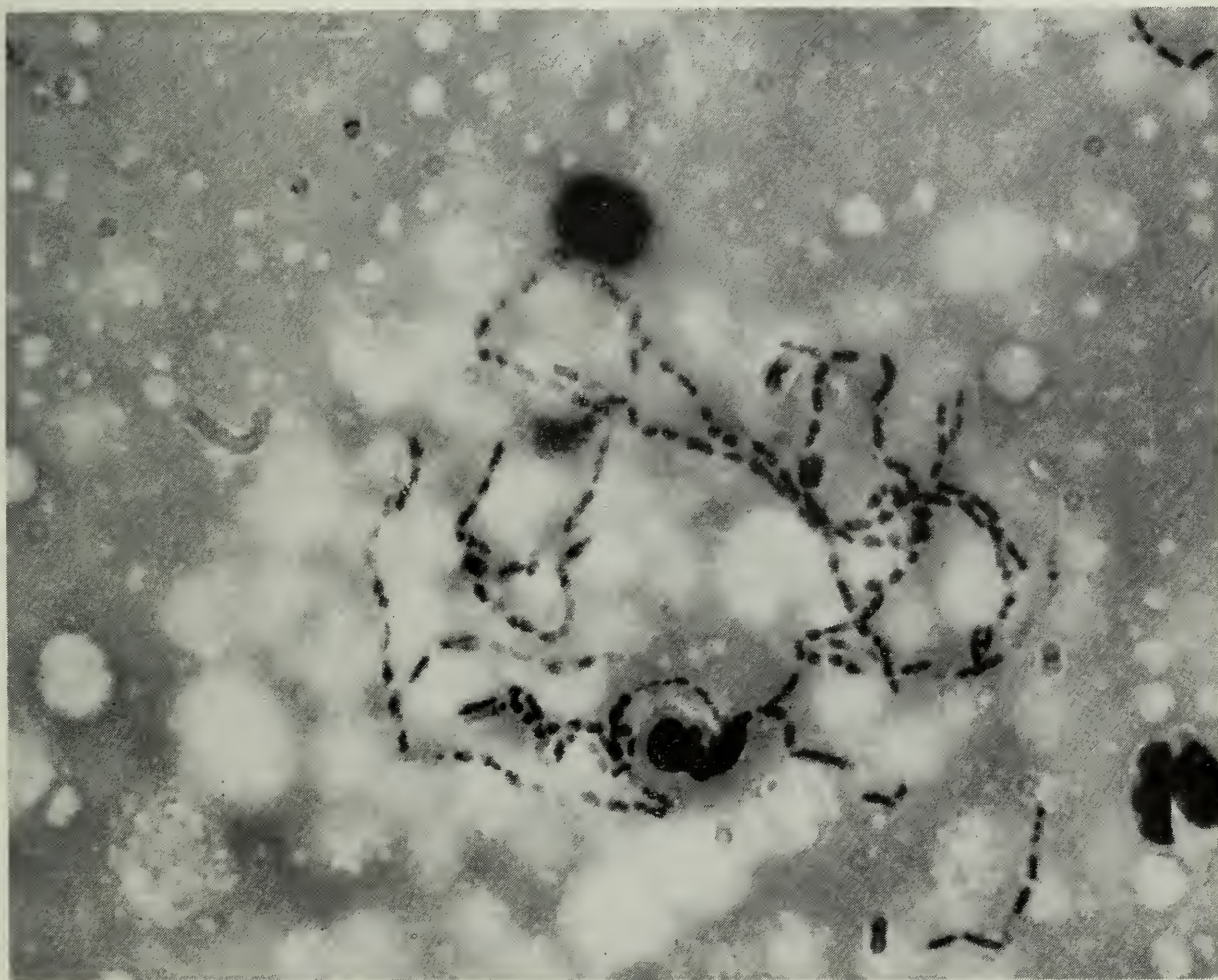
This organism, more properly called *Micrococcus pyogenes*, var. *aureus*, is becoming increasingly more frequent in the herds of this province. It not only causes mastitis in cows but is responsible for a number of infections, such as boils, in man and animals. *Staphylococcus aureus* is so wide-

spread that it is difficult to prevent infection. Staphylococcal mastitis frequently appears in animals freed of *Str. agalactiae* infection by antibiotic therapy.

Staphylococcal mastitis is usually of a mild chronic type, but a severe acute mastitis sometimes develops. There is some evidence that hypersensitivity, resulting from repeated exposure to the causal organism, is a factor in this form of mastitis. Control can be attained by a proper combination of diagnosis and treatment, although a perfect technique has not been worked out. Particular attention should be paid to management, sanitation, and the elimination of affected cows which do not respond to repeated treatment.

Miscellaneous Microorganisms

It would appear that almost any species of organism, gaining entrance to the udder in sufficient numbers, may produce infection. For no apparent reason, many normal inhabitants of the cow's environment may suddenly acquire invasive ability. Sheer weight of numbers is sometimes, but not always, the decisive factor in such a case.



Photomicrograph of milk taken from an infected udder showing pus cells and pathogenic bacteria.

Pseudomonas aeruginosa is responsible for mastitis in occasional herds. Mastitis caused by this organism is of the chronic type, with frequent acute flare-ups. *Pseudomonas* organisms are resistant to many of the commonly used therapeutic agents, and treatment is likely to have poor results. These organisms are common inhabitants of soil and water, and it is probably from such sources that the infection originates. Control lies chiefly in prevention by good sanitation, particularly of milking machine teat cups. The organisms are almost completely resistant to the quaternary ammonium compounds (see page 38) but, by replacing these compounds with more effective disinfectants in the milk house and barn of affected herds, some success has been gained in preventing the spread of infection and eliminating reinfection.

Coliform organisms are responsible for acute mastitis in some herds. Onset of this type of mastitis is sudden and frequently accompanied by very high temperatures. Unless prompt treatment is given, death may result within one to five days. Coliform mastitis may become gangrenous, although this is not frequent in Ontario.

Corynebacterium pyogenes: Mastitis caused by this organism is rather rare in Canada though very frequent in England and Europe where it is known as "Summer Mastitis". The disease is of the acute type, and as seen in Ontario is characterized by a foul-smelling thick secretion. Such cases seldom respond to treatment.

Yeasts have been isolated from the milk of affected cows in sporadic outbreaks of mastitis. The infection is acute, is frequently accompanied by a very high temperature, and usually subsides after 6 to 7 days. A number of different yeasts have been implicated. Yeasts have been introduced into the udder on unsterile tips of mastitis ointment tubes, and from teat cups kept in "Dry storage" between milkings. Since yeasts are resistant to the usual antibiotics they may multiply rapidly in the udder while treatment prevents multiplication of other organisms. The use of the usual antibiotics in these cases is useless and may be detrimental.

DIAGNOSIS

Methods of diagnosing mastitis may be separated roughly into two divisions; (a) Physical examination of the udder and milk for clinical symptoms and (b) Chemical and bacteriological tests on the milk to determine the presence of abnormalities and the number and kinds of microorganisms present. Without a complete diagnosis, treatment is frequently useless and often actually harmful.

Physical Examination of the Udder

If inflammation of a mammary gland is allowed to continue, certain changes take place in the tissue of the gland. These changes vary depending upon the type of microorganisms causing the inflammation and the duration of infection. In many cases the changes can be detected by

Careful physical examination of the udder. The normal udder should be soft and pliable after milking, although occasionally one sees a normal udder with the four quarters of relatively firm consistency, sometimes called meaty.

In acute infections the affected quarter is hot, swollen and hard. It will show marked contrast to the other quarters especially after milking and can be readily observed by an alert dairyman. In chronic infection one may observe an enlarged quarter caused by extensive fibrosis (scarring) of the gland tissue. In the majority of cases careful palpation of the quarter after it has been milked is necessary to detect the sites of infection, which are areas firm to the touch. A thickening of the teat cistern is also a sign of infection. Treatment of quarters that show tissue change is less likely to affect a permanent cure, which fact indicates the need for early diagnosis and treatment.

Physical Examination of the Milk

The nature of the milk varies widely in different udder infections. Frequently the first observation made is the failure of milk to filter properly. This preliminary diagnosis may indicate neither the quarter nor perhaps the cow which is affected. Early detection is possible by using the strip cup. The regular use of this inexpensive equipment to examine the foremilk of each quarter will enable one to see the small flakes or clots which are the first signs of mastitis. In advanced cases firm clots and stringy secretion will be present and the milk will have an abnormal colour. (The strip cup should be cleaned and disinfected after each milking. The cleaning of the screen of the filter-type can best be accomplished with a solution of lye.) Bloody milk usually results from damage to a small blood vessel either from a blow or from extensive swelling at the time of calving. If the bloody milk shows no flakes on the strip cup, infection is unlikely. It must be emphasized that in chronic infection, the milk may appear and taste normal. Therefore, more sensitive tests as indicated below must be employed.

Chemical and Bacteriological Tests on the Milk

(a) Field Tests

Bromothymol blue test

This is a chemical test based on the fact that in many cases of mastitis the acidity of the milk is decreased. In this test an indicator which changes colour according to the amount of acidity present is mixed with freshly drawn milk. Papers impregnated with the indicator are sometimes used and provide a simplified method in which the milk is dropped on to the paper or the paper dipped into the milk. Normal milk produces a yellowish green colour, suspicious milk a bluish green and definitely abnormal milk a blue colour.

Bromothymol blue is the most widely used indicator although Bromocresol purple has been used in a similar test. Neither of these tests are



The use of the strip cup to detect abnormal milk.

considered very reliable, and probably only the more severely infected cases are indicated, with the possible exception of a period during mid-lactation.

Whiteside test

The Whiteside test is a simple field test for the presence of mastitis, in which five drops of fresh foremilk are mixed with one drop of normal

sodium hydroxide on a glass plate. If the milk is abnormal a precipitate will form after 20 seconds. The precipitate probably results from reaction of the sodium hydroxide with the leucocytes in the milk, since the results of this test closely parallel the total cell count of the milk. The Whiteside test is possibly the most accurate field test so far devised.



Samples of positive and negative Whiteside tests. The two on the left positive, on the right negative.

Resazurin test

The resazurin test was originated for grading the quality of milk and is widely used for that purpose, but it can also be used as a field test for mastitis. It has been shown that very rapid reduction of the resazurin dye is accomplished by leucocytes in fresh milk. The test is performed by mixing accurately measured amounts of standardized resazurin dye and fresh milk from individual quarter samples. The mixture must be incubated at 37°C for one to two hours by which time abnormal milks will have undergone a colour change to pink or in very bad cases complete decolourization will have occurred.

(b) Laboratory Tests

Chloride test

It has been known for a long time that milk from cows with mastitis tastes salty. Based on this observation a test is used which determines the actual percentage of chloride in milk. The test requires laboratory facilities and the diagnostic results, while more reliable than those of the bromothymol blue test, are not always accurate. From the results of the test one cannot distinguish mastitis from early or late lactation, or abnormal milk caused by injury. Also there is normally great variation in the chloride content in the milk from different cows, and even between the first, middle and last milk of one milking from one cow.

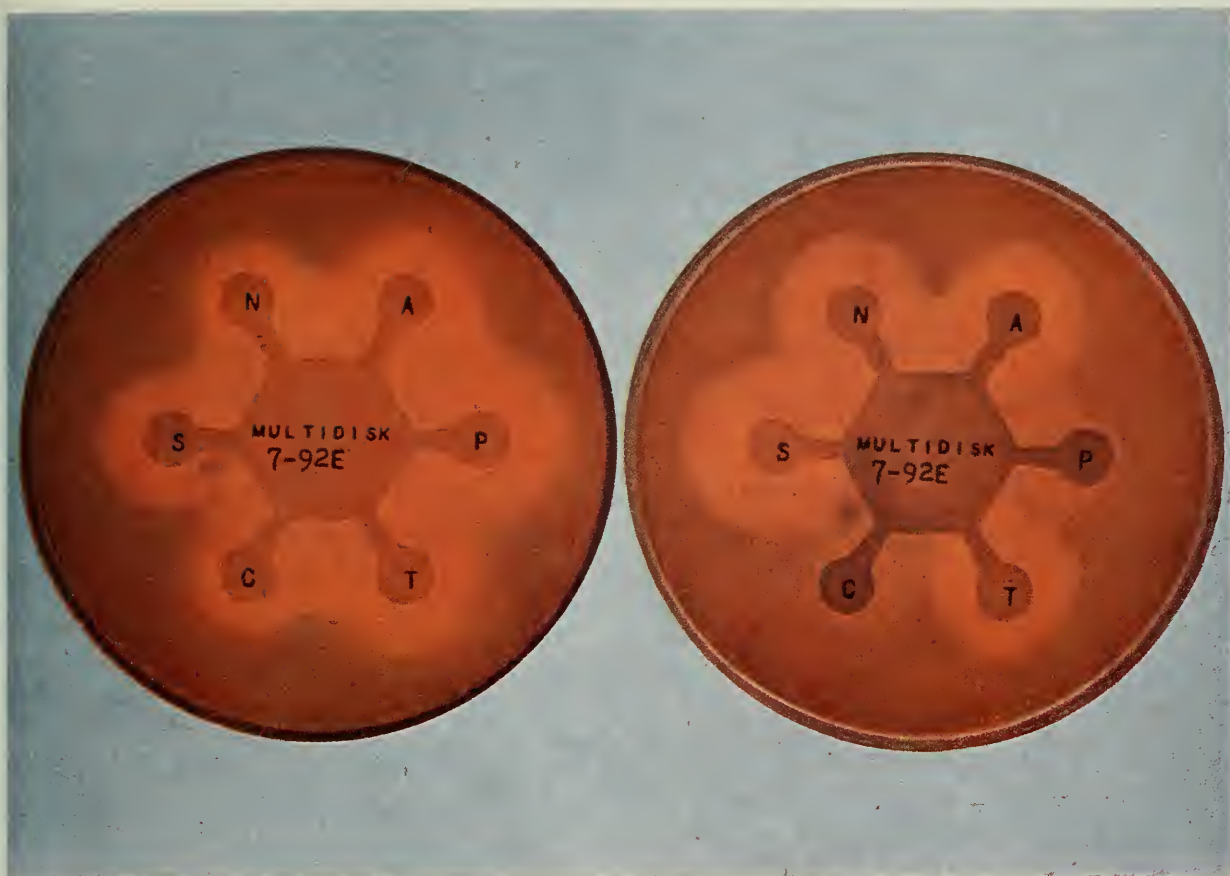
Catalase test

This is a test for the presence of the enzyme catalase. There is a rough relationship between the amount of catalase in milk and the number of leucocytes. The test is rather sensitive, thus giving some false positive results, but on the whole it is reasonably accurate in detecting abnormal quarters.

Total cell count

White blood cells or leucocytes are an important part of the body's natural defence mechanism against bacteria and other foreign irritants, and their presence in excessive numbers in the milk indicates stimulation of the defence mechanism against some invader. The fact that the cell content of milk may be governed by the stage of lactation must be taken into account, however, as high counts are to be expected immediately after parturition and during the drying-off period.

There is no unanimity of opinion on what is the normal number of cells in milk, but it is generally agreed that a count in excess of 500,000 per ml indicates an established infection. Some investigators have found histopathological conditions wherever the counts exceeded 21,000 per ml. While results of the test do not help to differentiate the various types of infection nor to discern the cause of the mastitis, this is probably the best single test for detecting udder inflammation although the cause of the inflammation must be determined by other means.



Tests to determine which antibiotics will prevent the growth of mastitis producing organisms. Note that the organisms on the right hand plate have grown right up to and around the two arms "P" and "C" of the disc, indicating that these organisms are insensitive to these two antibiotics.

Cultural methods

Unless one knows what causes the inflammation indicated by abnormal milk and elevated cell counts it is not possible to treat mastitis intelligently nor to prevent the waste of expensive materials, since there is no panacea for mastitis. Each kind of microorganism needs different treatment, and variation may even occur between different strains of the same organism in their susceptibility to chemicals and antibiotics.

Laboratory examination of the milk must, therefore, include procedures for growing and identifying any microorganisms present in the milk. This is done by drawing milk aseptically from individual quarters; streaking small quantities on culture media and incubating until the organism grows and produces visible colonies; and finally identifying the predominant organisms. Tests should then be made to determine which drug or antibiotics will kill the organisms that have been isolated. All these procedures require the services of a well equipped laboratory and experienced personnel.

Taking Milk Samples for Laboratory Examination

In the laboratory milk submitted for examination is subjected to procedures for determining the type of microorganisms present. It is necessary, therefore, to take any samples for laboratory diagnosis in such a

way that only those organisms present in the udder will be found in the milk sample. The following procedure is recommended:

(N.B. Samples should usually be taken just before milking.)

1. Wash the cow's teats and udder preparatory for milking.
2. Thoroughly swab the end of the teats with cotton batting soaked in alcohol. Have the cotton soaking wet, and make sure that all dirt is removed from around the teat opening.
3. From each teat strip out three or four streams of milk onto a strip cup.
4. From each quarter withdraw a sample into a separate sterile sample vial (In Ontario these vials are available from practicing veterinarians) provided by the laboratory for that purpose. If any dirt, dust or other matter gets into the vial from the cow or your hands or clothes, discard the sample and take another one in a fresh vial.
5. Cool the samples, and have them delivered to the laboratory as soon as possible.
6. Make sure that all vials are properly marked, and that all the information asked for is on the identification and history sheet. This is essential for accurate diagnosis.

Summary

In summary it may be said that the diagnosis of mastitis should include several tests; physical, field and laboratory. Diagnosis should not be merely a snap judgment on the part of one person, but should be based on the information obtained from all the tests that have been carried out. Laboratory tests will often show that more than one causal organism is present among cows in a herd and sometimes even among quarters of a single cow. Treatment, as indicated in the section on that subject, must be aimed at the particular causal factor in each case.

TREATMENT

Probably for no other disease of animals has treatment been so widely used and abused as for mastitis. Over the years scientific literature has contained many articles on agents and methods for treating this disease, and in a bulletin of this nature it is impossible to deal comprehensively with all of these. It is important to realize that the treatment of mastitis should be regarded as only part of the control program. Treatment alone will not maintain a clean herd although it may temporarily check the infection. The treatments employed for mastitis may be divided into two categories: (1) Symtomatic, that is relieving the symptoms and (2) Specific, that is removing the infecting organism.

Symptomatic Treatment

Symptomatic treatment is employed in acute cases of mastitis and should be conducted under the direction of a veterinarian. The following recommendations are usually suggested:

1. The infected quarter should be milked frequently as long as no medication has been introduced.
2. The cow should be put in a comfortable stall, well bedded and kept free from draughts.
3. The ration should be reduced, particularly the concentrates which should be kept to one-third, and a lighter feed such as beet pulp substituted.
4. If the quarter is markedly inflamed, hot or cold packs should be applied for one hour, two or three times daily.
5. If the infecting organism invades the blood stream of the cow causing septicemia or blood poisoning intravenous administration of antibiotics and supportive therapy should be given.

Specific Treatment

With the advent of sulfonamides and antibiotics it was found that these drugs given directly into the mammary gland would destroy or inhibit many pathogenic bacteria and thus reduce inflammation. A curative agent for intramammary treatment of mastitis must be: (1) active, in very low dilution, against mastitis bacteria and (2) non-irritating to the gland tissue. Many promising agents for treatment are unsatisfactory because they damage the delicate tissues of the mammary gland. A number of antibiotics, e.g., penicillin, fulfill both requirements. In order to exert their maximum effect antibiotics must be in contact with the organism in the gland for at least 72 hours. Most of the agent inserted into a quarter is removed during the subsequent milking; therefore one of the following measures is usually taken:

1. Treatment is administered after each milking.
2. The agent is introduced into the mammary gland and the quarter is not milked. This is not wise with high producing animals but it may be employed with cows that are nearly dry.
3. The agent is combined with a preparation whose action aids in retaining it in the gland; thus some antibiotic ointments can be inserted and adequate levels be maintained for 48 hours. A number of available preparations will effect the retention of the agent in the gland.
4. Large initial doses are sometimes given in order to maintain adequate levels of the agent in the milk. In some cases this may be satisfactory although it is usually a waste of material because a large percentage is removed by milking and this necessitates further treatment after 48 hours.

Too often treatment has failed because the agent was not kept in the udder in a high enough concentration and for a sufficient length of time.

Limitations of specific therapy

Certain limitations need to be recognized in using therapeutic agents:

1. Mastitis may be caused by one of a number of different microorganisms but no agent is effective against all types, e.g., penicillin is effective against *Streptococcus agalactiae* infection but completely ineffective against *Pseudomonas* mastitis. One can determine in the laboratory those agents that would be ineffective against certain microorganisms.

2. Some bacteria that cause mastitis are capable of developing resistance to one or more agents; thus an antibiotic in a certain dose may be effective one month but totally ineffective a few months later. Inadequate and promiscuous treatment favours the development of such resistance.

3. In some infections the organisms are located in small lesions within the gland and it is impossible for the agent to reach all sites of infection because some are protected by scar tissue. In such cases it may appear from laboratory tests that certain antibiotics should be effective, but the physical condition of the quarter prevents their action.

4. The microorganisms in the quarter are not destroyed at a uniform rate. The initial treatment with the right agent reduces the number to such an extent that clinical improvement is noticed. If however, because of this improvement the full course of treatment is not given and some microorganisms are left in the gland, they may again multiply and reproduce the disease.

When one considers the limitations of specific treatment, failures can be understood. Combinations of two or more drugs or antibiotics have been used in attempts to produce an agent which would act against most of the microorganisms causing mastitis. Such formulations, however, have limited value. Whenever possible the type of microorganism should be determined and the specific drug given.

Therapeutic Agents and their Administration

Many agents are available for treatment of mastitis. For each the required dosage is different, both in the amount used and in the frequency of application, and these will vary again with the type of infection. For best results it is important to follow the recommendations of a veterinarian. Because of these facts and since new drugs or combinations of drugs are consistently appearing, it is impossible to make definite recommendations in a bulletin such as this, for they would be outdated rapidly. The effectiveness of any treatment should be checked by having samples submitted for laboratory examination three to four weeks after treatment.

(a) Antibiotics

Since their introduction in 1944 antibiotics have been the most useful agents for the treatment of mastitis and many infected quarters have been cured through their use. Antibiotics are usually administered directly into the gland through the streak canal because it is difficult to secure adequate concentrations by other routes. In successful cases, the response to treatment is usually rapid and dramatic.

Some antibiotics commonly in use are: penicillin, which is effective against streptococci and some staphylococci; streptomycin and neomycin effective against coliform mastitis although large doses are usually required; aureomycin, terramycin and tetracyclines effective against a wide variety of streptococci, staphylococci and coliform bacteria.

(b) Sulfonamides

These drugs have a low solubility in milk and are, therefore, usually given by injection into the blood stream. They are also sometimes given by mouth. By either method it is necessary for the drug to pass from the blood into the milk; therefore the concentration in the milk is usually not high enough to be effective, and treatment with these drugs is not usually very successful.

(c) Administration of treatment

It may be necessary for the owner to complete the treatment schedule started by the veterinarian. In such instances great care should be taken since it is possible to introduce into the udder bacteria which may be resistant to the drug administered.

It is important that the following steps be taken:

1. Give the treatment immediately after milking.
2. Wash the teat with disinfectant and dry with a paper towel.
3. Swab the end of the teat with alcohol.
4. If the antibiotic is in a tube remove the cap and immediately insert the nozzle into the teat. Squeeze the entire contents of the tube into the gland and massage the teat and udder for dispersion. Where the treatment is given through a teat siphon sterilize the siphon by boiling. Under no circumstances use one teat siphon or 1 tube of ointment in more than one quarter.
5. Do not reduce the amount or number of treatments outlined by the veterinarian, even when clinical improvement is noticed.

Immunization

Ideal vaccination would protect cattle with healthy udders from infection, and decrease the severity of the disease in those animals already infected. There are many diseases which can be prevented by immunization, but few in which the severity can be decreased by the use of vaccines

after infection has taken place. For a long time immunization by vaccination has been considered a possible means of controlling bovine mastitis. Immunization against mastitis is difficult to achieve for two reasons: (1) A number of different microorganisms are responsible for the condition, and immunization against any one infection will not protect the animal against another. Therefore, to secure complete protection one would have to vaccinate with a number of different microorganisms, unless several could be combined into one polyvalent vaccine. (2) In immunization of cattle a high level of protective antibodies is needed in the milk to prevent infection. This is not easily accomplished because the antibodies, although present in the blood serum, may not pass into the milk in adequate amounts.

In spite of the above limitations, beneficial results from immunization have been reported by herd owners and practising veterinarians. The material used may be either (a) an autogenous bacterin, prepared by a laboratory from bacteria which have been isolated from infected cows of the herd in which it will be used, or (b) a stock bacterin, which contains bacteria from outside cases of mastitis and which has been prepared by a commercial pharmaceutical firm. Usually these contain two or three different types of bacteria in an attempt to protect cattle against more than one type of infection. Experience has shown generally that animals should be vaccinated every six months, and that several injections are required at each vaccination. Up to the present time no large scale controlled experiments have been carried out and therefore, there is no clear cut evidence regarding the value of immunization.

MANAGEMENT OF THE MILKING HERD

What has management to do with mastitis? How can the farmer cause or prevent mastitis?

Many of those struggling to control this waster of dairy cows are coming to the conclusion that management is the major factor governing the amount of infection in a herd, and that the farmer with a problem of mastitis holds the power in his own hands to prevent the ravaging of his herd. The herd manager is more responsible than any other single factor. There are some who will go further and say that management is the sole responsible factor and that neither germs nor treatment are important.

This section will be devoted to some of those factors which are part of "management". Taken individually probably none is instrumental either in inducing or in preventing mastitis, but taken together they form a powerful weapon for good or bad in controlling the disease.

Cows which have had mastitis are more likely to contract it again and even more attention must be paid to the management of these animals.

Protection of the Udder

(a) Stable Construction

General—Stables should be constructed so that the cows are not subjected to drafts, and that they are kept dry and clean. Cows, like humans, are more resistant to disease if comfortable. Because drafts are particularly irritating make sure that all windows fit tightly, hay and straw chutes are covered, the silo chute closed, and that no drafts enter around doors or the litter-carrier track. There should be little wonder at a congested udder, if the cow is forced to stand or lie down with a cold draft blowing right on her udder since, once an udder is irritated in this way, it is open to attack by germs. Cows will adjust themselves to cold, but never to drafts.

In stanchion-type barns a plentiful supply of clean, dry bedding must be maintained under the udder. Cement floors are cold, and udders will not stay healthy if adequate insulation, in the form of bedding, is not provided on top of the cement.

Stall width—Stalls must be wide enough. The wider they are the better, because cows crowded together by narrow stalls will have more udder and teat injuries. It has been shown that there is a direct relationship between the width of stalls, the number of injured teats and udders, and cases of mastitis. Four feet is the minimum width for a stall. Where this width is not possible, a stall brace between each two cows will keep each cow's feet in her own stall.

Stall length—Stalls should be long enough to allow cows' udders to be well forward from the gutter when they are lying down. An electric cow trainer will permit the use of longer stalls, save bedding and keep the barn clean as well as help to maintain healthy udders.

Loose-housing barns—This type of barn is becoming very popular in certain areas, particularly in combination with a milking parlour. Published reports indicate that loose-housing results in fewer udder injuries and, generally speaking, healthier udders. If a proper supply of bedding is maintained the use of the loose-housing barn will not result in increased mastitis, and may even help to reduce the incidence.

(b) Correct Milking

Hand milking—Milking by hand is now not very common and little need be said about it. It is generally agreed that less mastitis occurs in hand-milked herds, although it is not unknown and milkers' hands are a potent source of infection. Sanitation is the most important factor in hand milking and this will be covered in the section dealing with preventing spread of infection.

Machine milking—Machine milking results in a higher incidence of mastitis than does hand milking, when other factors, such as sanitation, are equal. It appears probable that machine milking results in irritation to the teats and udder, since leucocyte counts and chloride content of milk tend to be higher in milk produced by this method. Great care should, therefore, be taken in operating the milking machine and in the milking

routine. The tissues of the mammary gland and teats are easily damaged, and must be treated with care and consideration if they are to remain healthy and continue to function efficiently.

The following points are important to remember in planning your milking procedure:

1. Have machine properly adjusted. The manufacturer of each machine recommends a definite vacuum at which it should be operated, and a definite number of cycles per minute at which the pulsator should be set. The teat cups and liners are designed to work most efficiently under these conditions, and your machine should be adjusted to them.

2. Stimulate milk let-down. Research indicates that the length of time the machine is on the cow is most important in udder health. Any factor which will speed up the milking will help to prevent mastitis. Stimulate the milk let-down by massaging the udder with a damp cloth or paper towel; milk several streams from each quarter by hand into a strip cup. This combination of massaging and fore-milking should reduce milking time by about one quarter.

3. Attach the machine within one minute of stimulating the udder. The stimulation is only effective for approximately four to five minutes, and the cow should be milked out within this time, or the benefit is lost and longer milking times are needed.

4. Remove teat cups as soon as milking is complete. Do not leave cups on too long as this will result in damage to the udder tissues. Do not remove cups from the teats until the vacuum is released. Do not pull the cups off roughly. Close the vacuum shut-off on your milker or the vacuum cock on the line, and break the vacuum by gently inserting a finger between one of the cups and the teat.

5. Stripping—by hand or by machine? Which is better is open to considerable argument. It has been shown that more clinical mastitis occurs among machine-stripped cows, than among those stripped by hand. Hands are just as likely or more likely to carry and spread infection, and infinitely more difficult to sterilize than milking machine teat-cups. Machine stripping, if done by a careful and experienced operator, provided the machine is adequately sanitized, is possibly the better method. Hand stripping would be preferable if the milker's hands were adequately washed and sterilized between cows, but this is difficult to accomplish in a milking barn.

(c) Feeding

Whether or not feeding has any significant effect on the incidence and severity of mastitis is a much debated point. Many people claim that certain feeds predispose the cow to mastitis. Despite fairly extensive investigations, there is no clear-cut evidence that heavy feeding or particular feeds have any marked effect on mastitis. There is some evidence that abundant good quality roughage may improve the general health and disease resistance of cows, and cows fed poor quality roughage

and large quantities of grain have shown a higher incidence of mastitis. There are also indications that in some seasons, cows may show a decreased resistance immediately after being turned out to pasture.

Heavy feeding for increased production may sometimes result in mastitis in certain cows. Such cases probably result from the extra strain that increased production places on a previous infected or otherwise predisposed udder, rather than from the type or amount of feed. Feeding a cow for maximum production subjects her udder to maximum effort, and any latent weakness is likely to be exaggerated. During treatment for acute infections, the feed should be reduced so that the udder is given the greatest chance for recovery.

(d) **Breeding**

In Canada little attention has been paid to resistance and susceptibility to mastitis as genetic factors. In both Europe and the United States, investigators have shown that susceptibility to mastitis is an inherited characteristic. The mechanism of this susceptibility or low resistance is not known, but there is definite evidence of its existence in certain cow families.

It is doubtful if cows which become infected before the end of the third lactation period should be used in a milking herd for breeding purposes. Also it would appear to be unwise to use a sire whose dams and sisters show susceptibility to the disease. Available evidence suggests that the history of family susceptibility should be taken into account when selecting bulls for artificial insemination units, since it may be possible for a sire in a unit to populate the farms of the area with susceptible daughters. Conversely a sire may transmit a factor for resistance, thus helping to control the disease.

Prevention of Spread of Infection

Many investigators have shown that the organisms usually associated with mastitis can and do persist for relatively long periods on the skin and coat of the cows, and on many of the normal contents of cow barns. In addition to primarily-mastitis-producing-organisms, for example *Strep. agalactiae*, infection is sometimes caused by microorganisms which are not basically pathogenic, but are normal inhabitants of the soil, bedding, faeces etc. Such organisms as *Pseudomonas*, *Esch. coli* and yeasts come under this heading. In small numbers they either do not enter the udder or, if they do, are taken care of by the normal defence mechanism of the cow. Where they are allowed by unsanitary conditions to build up on the teats of the cow, the milking equipment, or milkers' hands, they cause infection through sheer weight or numbers or inability of the cow's defence mechanism to overcome them.

Usual methods of farm sanitation, while adequate for producing milk with a low bacteria count, frequently do not prevent disease. It is unreasonable to expect that any treatment will render a cow immune to

attack by all microorganisms or permanently cure a cow subjected to continuous reinfection from improperly sanitized surroundings.

The accepted route for invasion of the udder is through the teat orifice and streak canal. Every effort should be made to prevent the building-up or depositing of large numbers of microorganisms of any kind near the entrance to this route.

Preventive measures can be classified in two groups: (1) Those designed to prevent the spread of microorganisms to the teats and udder of an uninfected cow: (2) Those concerned with reducing the chance of udder invasion by removing, killing or preventing multiplication of any organism which, through chance, by-pass group I measures.

(a) Protection of Uninfected Cows

Those organisms which cause mastitis originate either from (1) the milk of an infected cow which might have active clinical symptoms or not, depending on the severity of infection, or from (2) commonly occurring organisms, not normally pathogenic, which for some reason have acquired temporary invasive ability.

Organisms of the first type are unlikely to be transferred from one adult milking cow to another, unless the cows are kept where the organisms can be transferred by contaminated bedding, human hands, or by any of the equipment used in the milking procedure which may come in contact with the teats and udder.

Bedding: Contaminated bedding cannot be disinfected, and should be burned or discarded. Care should be taken not to let milk from infected cows spill on the bedding. When an infected cow is moved to another location, her stall should be cleaned completely and new bedding provided before another cow is moved in. Prevent bedding from an infected cow being pushed into the next stall.

Udder cloths: Cloths, cotton or linen towels, sponges, etc. are not satisfactory for udder washing, unless a separate one is used for each cow, and boiled after each use. It is all but impossible to sterilize a cloth with chemicals. It has been shown that up to 5 hours treatment with Sodium hypochlorite solution (2000 p.p.m. available chlorine) is required for destroying *Str. agalactiae* on an infected udder cloth. Paper towels are most satisfactory since they can be thrown away after a single use, and thus neither dirt nor infection is carried back to the disinfectant solution. It is, therefore, possible to use less solution. Special, extra-strong paper towels are available for use in udder washing. Paper towels should not be soaked in disinfectant, since they will often disintegrate and will be rendered useless. There is no problem if they are dipped in the solution immediately before use. Paper towels should be disposed of by burning or burying, as they rot slowly and blow around the field if discarded with the manure.

Teat-cups

Dipping: The teat-cup liners of the milking machine pick up organisms from milk as it passes through them, and from the teat skin with which they come in intimate contact during milking. Teat-cup dipping, like any other disinfecting procedure, takes time but, with a little ingenuity, it can be worked into the milking routine. The teat-cup can be dipped while the milker bucket is being emptied, or while the next cow's udder is washed.

The following disinfectant solutions are satisfactory: Sodium hypochlorite used at a minimum concentration of 250 parts per million, if preceded by a short rinse once in and out of a pail of luke warm water. Iodine used in the form of an Iodophor, (see p. 38) at a minimum concentration of 50 parts per million. A prerinse is not absolutely necessary, but it is desirable.

Both of these solutions should be warm (145° - 150°). Sodium hypochlorite solutions should be renewed when they become cloudy with contaminating material.

Storage: In our opinion, the most satisfactory way of storing teat-cup liners between milkings is by storage on a solution rack or in a crock containing sodium hydroxide solution. Where "dry storage" is used, large numbers of potentially mastitis-producing organisms can and do accumulate on the liners. Sodium hydroxide is cheap, preserves rubber and prolongs the life of liners.

A minimum concentration of 0.5% is necessary, and 1% is preferable. This can be made by adding slightly less than a 1 oz. scoopful of sodium hydroxide flakes to 1 gallon of water. (See note on p. 37 regarding hard water).

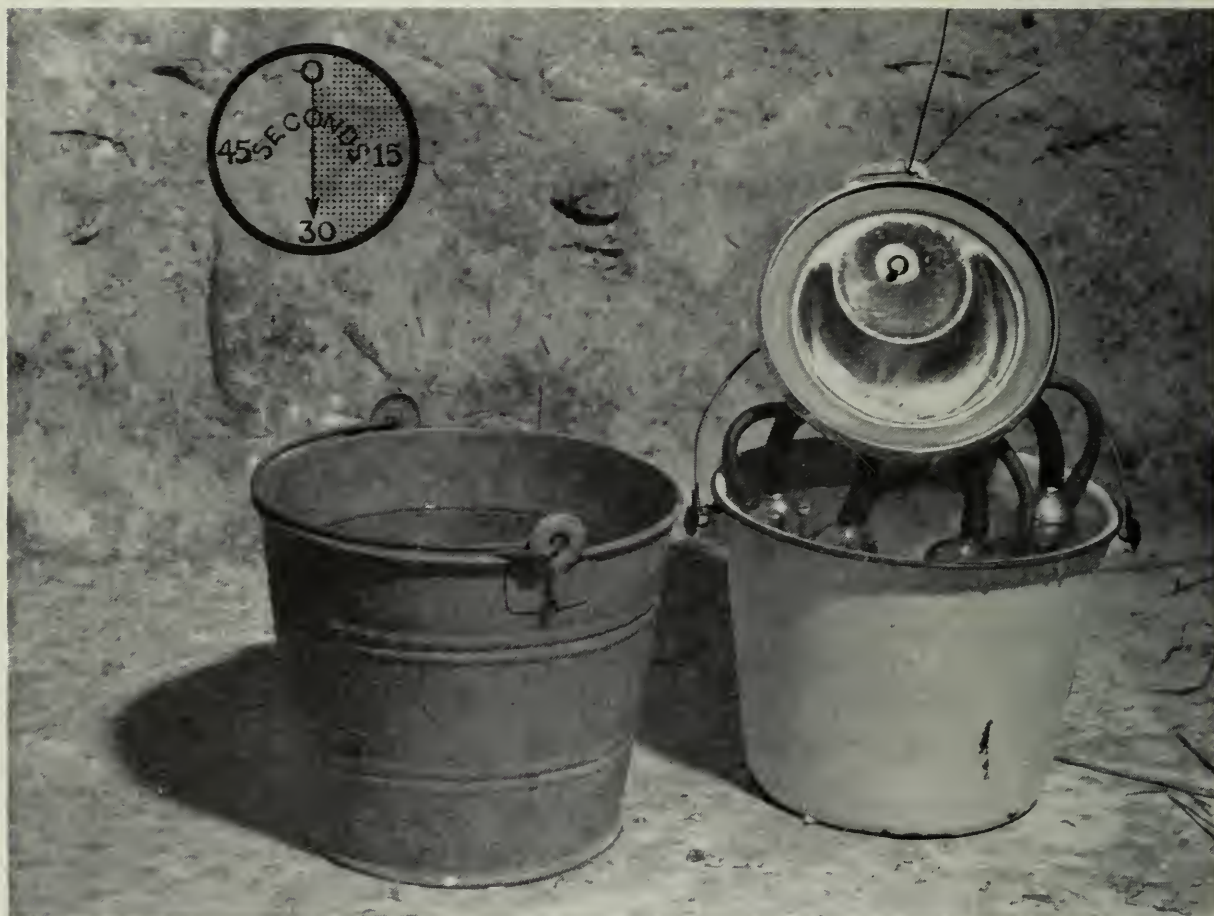
Disinfection of hands—Human skin is very difficult to disinfect. Microorganisms invade and live in the outer layers of skin, and become very resistant to attack by disinfectants. Badly cracked or chapped hands provide an excellent repository for microorganisms.

It is essential that anyone handling cows' teats should keep his hands completely clean and thoroughly disinfected at all times. Before starting to milk, hands should be thoroughly washed and scrubbed with warm water and soap, and then rinsed in the disinfectant solution used to wash udders. Hands should be dried on a fresh paper towel, not on a pair of dirty overalls. Regular use of a soap containing hexachlorophene or G-11 will help to ensure a minimum number of microorganisms on one's hands.

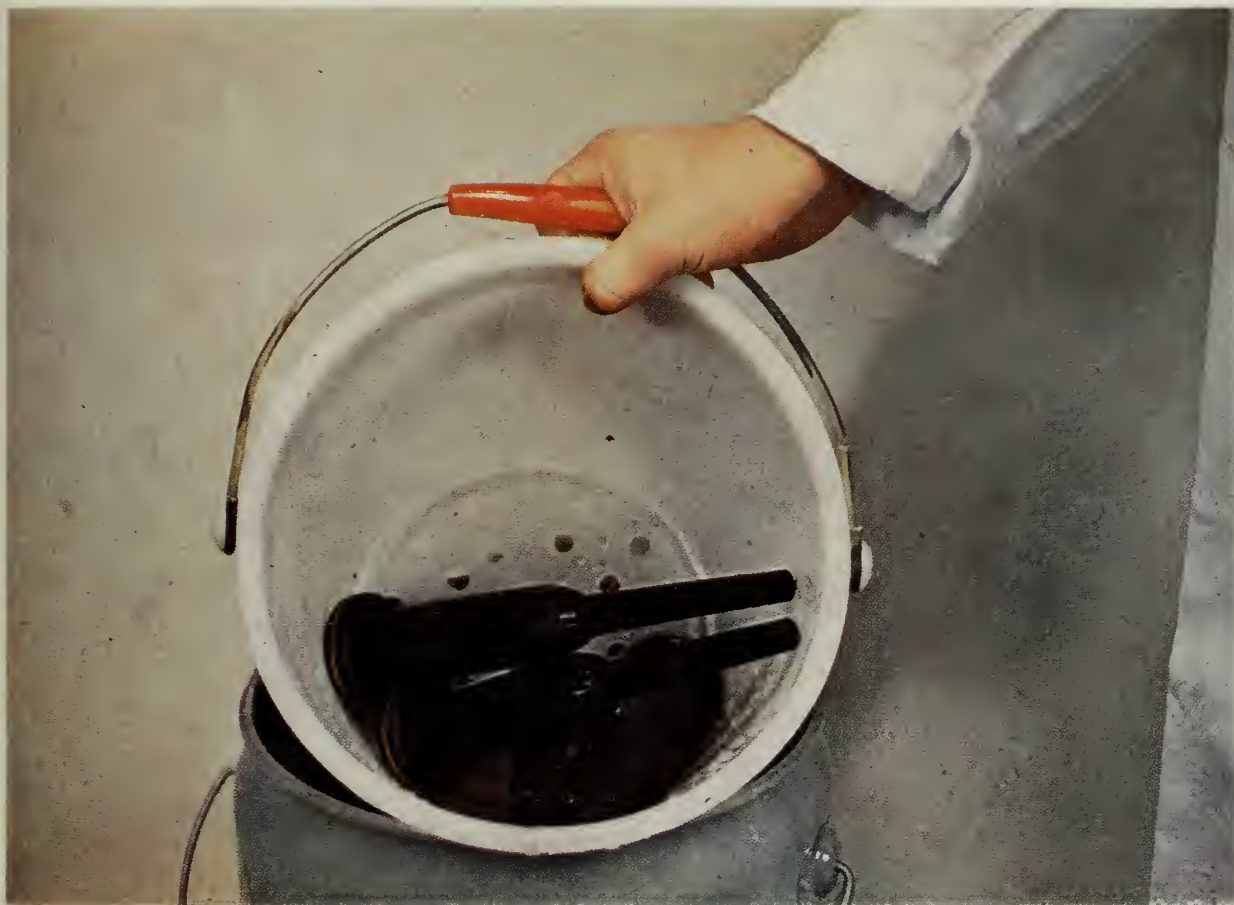
It is particularly important to take care of the hands when hand-milking. Hands are far more difficult to disinfect than are teat-cup liners. If your herd has no mastitis, be extremely cautious about letting someone from another farm milk your cows, especially if he comes from a farm where there is mastitis.



Paper towels for washing udders.



Dipping teat cups to prevent spread of disease producing organisms. They should be in the solution a minimum of thirty seconds.



Lye storage. A simple way of storing teat cup liners between milking.



Badly cracked hands. Hands like this may be a source of infection.



This barnyard shows many of the undesirable features outlined in the text.

Calves: Many farmers allow a calf or calves to suck a badly infected cow rather than include the milk in that shipped to the dairy. This is probably a poor thing to do, particularly if several calves are running together. In sucking an infected cow, the calf will pick up organisms on its mouth and, if it sucks another calf, as frequently happens, the organisms will be transferred to the immature teats and mammary gland of the second calf. Mastitis in newly-freshened first calf heifers has been blamed on this practice. This same criticism applies to the practice of pail-feeding calves with mastitis-infected milk. The saliva of young calves does not possess any antibacterial property, and these practices may result in infection of the calf involved and the others with which it comes in contact. Feed calves with milk from mastitis free cows or milk which has been heated. Prevent calves and heifers from sucking their pen mates, if necessary by muzzling.

Flies: Some investigators have shown flies to be an important factor in spreading certain types of mastitis, while others have found flies to have little to do with it. From these reports it would seem that flies can



To enter and leave this barn, cows must pass through this narrow passage between an attached henhouse and the manure pile, and over a high step at the door.

and will pick up mastitis organisms if they feed on the milk on the teats after a cow is milked. By moving from teat to teat or from cow to cow, they will spread these organisms. If flies are seen in the cows' surroundings, and alight on the cows' teats it can be assumed that they are potential spreaders of mastitis since mastitis organisms have been found on such flies. Efforts should be made to keep flies away from the cows and their environment by screening all windows and doors, by using suitable sprays, and removing all potential fly-breeding areas from the cows' surroundings.

Barnyard, lanes and fields: Mastitis often follows injury to the udder, and all too often such injury results from the udder coming in contact with stones, logs, barbed wire, farm machinery and numerous other obstacles allowed to clutter up the loafing and grazing areas of the farm. Such areas should be free of any objects which might injure the cows' udders.

Barnyards should be well-drained so that they remain dry at all times. Cows should not be allowed to wallow through mud and manure every time they enter or leave the barn. Such conditions invite udder infections.

New additions to the herd: If it is necessary to increase the number of cows in a milking herd the best way is, undoubtedly, by means of heifers

raised on the farm where they are to be milked. If this is not possible the next best thing is to buy bred heifers. While heifers do sometimes freshen with an infection, the chance involved of bringing mastitis into the herd is infinitely less than from older cows, either dry or actively milking.

As explained in an earlier section very mild infections occur which cannot be detected by visible symptoms. Some cows may be infected for considerable periods of time before clinical symptoms are seen. These "carrier" cows can be potential sources of infection to other cows. It is, therefore, clear that no cow should be brought in which has not been examined both physically and by laboratory tests as outlined under "Diagnosis". If this is not possible or if you are assembling a new herd, buy the cows on a guaranteed basis, under which they can be returned if found to be infected. Isolate all such cows immediately on arrival at your farm. Have a veterinarian examine them and take individual quarter milk samples to be submitted for laboratory examination.

Mastitis is difficult to control. Do not buy someone else's troubles.

(b) Removing, Killing, and Preventing Multiplication of Microorganisms on Cows' Teats

Udder washing: Washing the udder and teats of each cow with a wet cloth before milking helps to produce clean milk and stimulates milk let-down. This will not, however, prevent the spread of mastitis.

The main reservoirs of mastitis-producing organisms, outside the udder, are the skin of the teats, the teat cups of the milking machine, and the milker's hands. In an experimental herd, failure to wash udders with an effective disinfectant resulted in more rapid spread of *Str. agalactiae* from cow to cow than did failure to dip teat cups. The kind and amount of disinfectant used in the udder wash-water will have a marked effect on the number of microorganisms adhering to teat-cup liners from the teat surface.

Visible dirty udders must be prerinsed with warm water and a cloth, then disinfected. Prerinsed and visibly clean udders should be washed with a paper towel, dripping-wet with disinfectant solution; one towel being used for each cow. After thorough washing, the towel should be wrung out and the udder dried with it.

Suitable disinfectants: Hibitane has been shown to be very effective for udder washing in herds with active clinical mastitis caused by *Str. agalactiae* or haemolytic *Staphylococcus*. It should be used at the rate of 1 oz. of 1.6% solution to 1 quart of warm water. For routine use, where clinical cases are not present, 1/2 oz. of 1.6% solution per quart of warm water may be satisfactory.



Washing udder with paper towel wetted with disinfectant solution.

Iodine (see Iodophors p. 38) at a minimum concentration of 100 parts per million or sodium hypochlorite at a minimum concentration of 500 parts per million is satisfactory for routine use. Some cows are sensitive to chlorine, therefore care should be taken to watch for any redness or rash on the teats. Some chlorine products contain excessive amounts of alkali, which will do more to cause skin rash than the chlorine.

Except when *Pseudomonas* infections are present, quaternary ammonium compounds may be used at a minimum concentration of 500 parts per million, if some other disinfectant, for example sodium hypochloride, is used for disinfecting teat cups.

Teat dipping: The practice of dipping the teats in a disinfectant solution, immediately after milking, is recommended by a number of authorities. This serves two purposes: (1) It removes at least part of the film of milk which will normally remain and dry on the teat after milking, providing nutrients for bacterial multiplication. (2) It kills any organisms which may have come from inside the udder with the milk, if the cow is infected.

If the disinfectant has a high bacteriostatic property, multiplication of any microorganisms on the teats will be reduced, if not prevented. This will require a disinfectant which is stable in the presence of organic matter.

On the whole teat dipping appears to be a sound, worthwhile practice, which can be particularly recommended in those herds in which infections continually reappear shortly after treatment. Solutions of the same type and strength as recommended for udder washing should prove satisfactory for this purpose.

MASTITIS AND PUBLIC HEALTH

In our civilization milk and its products have become major items of human diet, especially for the very young. It is, therefore, natural that more and more emphasis is placed on assuring that milk supplies available for consumption be pure. For this reason, all milk products are subject to examination by Public Health authorities. Regular examinations are carried out to ensure that milk contains a minimum number of bacteria, nothing that will cause disease in the consumer and that it is free from dirt, impurities and abnormality.

Mastitis, as we have seen, results in microorganisms entering the milk from diseased udders, abnormal milk physically and chemically, and incorporation in the milk of the chemical and antibiotics used in intramammary treatments. The question arises "Do any of these factors render milk and its products unfit for human consumption or otherwise affect human health?"

Number of Organisms in Milk

Public Health departments try to ensure that milk reaching the public contains a minimum number of microorganisms. It is generally agreed that milk aseptically drawn from healthy cows contains very few organisms. Where large numbers are found in milk from healthy animals either they have come from a source other than the cows' udders, or have resulted from multiplication of the original few because the milk has not been efficiently cooled and kept cool.

If cows with mastitis shed large numbers of microorganisms in their milk, and this milk is included in shipments to the dairy, will the total bacteria count of the shipment be affected? A number of investigators have shown that, only in very exceptional circumstances will there be sufficient organisms shed by mastitis-infected cows to affect significantly the bacteria count of the milk from an entire herd. The actual number in the milk from any herd will vary with the percentage of infected quarters and the relative amounts of milk produced by those quarters. Failure to cool the milk promptly to safe, low temperatures can result in increase of those organisms originally present, and this factor is likely to be more

important than the initial number. In general then it can be said that only in very exceptional circumstances will the presence of mastitis in a herd be likely to affect the total number of organisms in milk significantly; other factors are much more important.

Leucocytes in Milk

One of the first actions of the body's defence mechanism in response to invasion by some foreign substance or organism is the production of leucocytes. These leucocytes accumulate rapidly at the site of infection for the purpose of ingesting and destroying the invader. Leucocytes are commonly called "pus cells" because they form a large part of the pus in an infected wound or boil.

Milk from cows with mastitis contains large numbers of leucocytes. In acute mastitis, the count may run to many millions per millilitre. In chronic mastitis, most infected quarters will shed over 500,000 per millilitre of milk. In addition to leucocytes, epithelial cells and other debris resulting from the infection will also be present. These abnormalities do not endanger the health of those consuming such milk, but they do offend one's aesthetic sense. In addition to this they cause difficulty in processing milk and its products.

Leucocytes form the greatest percentage of the material in sludge in homogenized milk, and a major part of the slime which accumulates in the bowl of a cream separator. While some cells can be found in milk from healthy cows, particularly in the early and late lactation periods, mastitis is the main cause of large numbers of leucocytes in milk.

Of particular interest to milk producers is the effect of leucocytes on resazurin tests, which are used quite widely in grading milk both by milk plants and Public Health departments. As discussed under "Diagnosis", there is a direct relationship between the number of leucocytes and the reduction of resazurin. Many milks grading "Poor (#2-3)" by the resazurin test would probably be "Good (#1)" if milk from cows with mastitis were excluded.

Importance of Specific Infections

Streptococcus agalactiae: Large numbers of *Streptococcus agalactiae* are shed in milk from quarters infected with this organism, although the likelihood of there being more than 1000 per ml. in herd milk is probably remote. This organism generally is not considered to be pathogenic to humans, although there are reports of the isolation of the organism from lesions in human infections. Pasteurization will kill the organism, therefore, where pasteurized milk is not available, milk from cows infected with this organism should not be used.

Other Streptococci: Streptococci other than *Str. agalactiae* found in bovine mastitis are not generally considered to be pathogenic to humans. There are, however, a number of cases on record where the organism causing mastitis originated from a human infection, such as a sore throat. In

these cases the organisms shed into the milk will be pathogenic to other humans. A number of human infections have been caused in this way. This is further confirmation of the need for caution in handling mastitis-infected milk.

Staphylococcus aureus: Unlike most other organisms causing mastitis, staphylococci are not always killed by the pasteurization treatment, since some strains of the organism are quite resistant to heat.

Many of the staphylococci causing mastitis are similar to those found in boils and other human infections, and many are indistinguishable from enterotoxin producers responsible for outbreaks of food poisoning in humans. In a number of these outbreaks it has been determined definitely that the responsible organisms originated from cows with staphylococcal mastitis.

Where milk containing these organisms is not rapidly cooled, toxin may be produced by the multiplying staphylococci. This toxin is thermostable, and even though the organisms themselves may be killed later in further processing, the toxin can be carried unaffected into the final product. Thus milk from cows with staphylococcal mastitis whether heat-treated or not, can be a potential public health hazard.

Miscellaneous Organisms: Coliform bacteria sometimes cause bovine mastitis and also human diseases. Possibly the most vicious of the latter caused by these organisms is enteritis in babies. This is caused by only a few strains of *Esch. coli*. Two of these strains have been isolated from mastitis in cows, and also from the faeces of humans on a farm where mastitis associated with this strain was discovered. The significance of this type of mastitis to public health is plain.

A number of outbreaks of mastitis caused by yeasts, indistinguishable from pathogenic human strains, have been reported from several countries. This suggests that mastitis caused by yeasts could be a potential hazard to public health.

Antibiotics in Milk

In treatment of mastitis, large quantities of chemicals and antibiotics are infused into the udder. These materials mix with the milk and, although a large proportion of the total infused, probably at least 50 per cent, is excreted from the udder during the next few milkings, detectable levels of penicillin in milk have been found for 14 days after infusion of 300,000 units.

Soon after the introduction of penicillin therapy, reports of difficulties encountered in the manufacture of a variety of fermented dairy products began to appear: cheese of all kinds failed to ripen normally; butter, buttermilk and similar products did not develop the required acidity. These difficulties were of course the direct result of the antibiotics acting on the organisms which form lactic acid and other by-products in the normal fermentation process. By modification of procedures and the

addition of penicillinase, an enzyme which inactivates penicillin, these difficulties were partly overcome. However, with the introduction of one antibiotic after another, the situation has been aggravated because so far the new materials cannot be inactivated in the same way.

Tests for milk quality, notably the methylene-blue reduction and resazurin reduction tests, have been affected by the presence of antibiotics, although the resazurin test because of its shorter incubation period, is not as subject to this difficulty as is methylene-blue. While prolongation of the reduction times has been the main problem, it has been shown that small amounts of certain materials used for intramammary treatment actually stimulate some bacteria. This can of course shorten the reduction time.

In addition to the purely economic aspect of the presence of chemicals and antibiotics in milk, questions as to those consuming such milk and its products have been raised in many people's minds. Microorganisms are known to develop resistance to many substances, particularly antibiotics, if they are constantly in contact with them. For this reason, difficulty is now experienced in the treatment of certain diseases which were subject to control a short while ago by antibiotic therapy. Public Health authorities are, therefore, greatly concerned over the possible development of resistant strains of human pathogens resulting from the continued presence of antibiotics in the milk supply.

In human medicine large numbers of cases of sensitization to antibiotics because of repeated treatment have been encountered. It is not unreasonable to expect that consumption of milk containing these materials can be a significant factor in sensitizing humans to them or in producing allergic reactions in those already sensitized. In recent reports it has been suggested that prolonged intake of certain antibiotics results in reduced thyroid activity, and that consumption of milk containing any of a number of antibiotics can upset the intestinal flora of humans, and result in a decrease in the synthesis of beneficial vitamins.

It is therefore plain that the presence in milk of the common chemicals and antibiotics used in mastitis therapy is not only detrimental to the production of a number of milk products, but a potential menace to the well-being of human consumers. Because of these factors, promiscuous use of chemicals and antibiotics in intramammary treatment should be discouraged, and milk from treated cows should be used for other than human consumption for a period after treatment. This period should be, it is generally agreed, at least 72 hours, since it takes this long before the antibiotics in milk fall to an insignificant level. Steps are under consideration to ensure that milk from cows undergoing intramammary treatment is withheld from milk shipments.

DISINFECTANTS

A bewildering multitude of products are marketed for disinfecting, sanitizing, cleaning and other similar purposes. Each product is claimed

BACTERICIDE DISINFECTANT DEODORANT

KEEP IN COOL PLACE

COMPOSITION

ACTIVE INGREDIENTS

SODIUM HYPOCHLORITE....OVER 3.25%

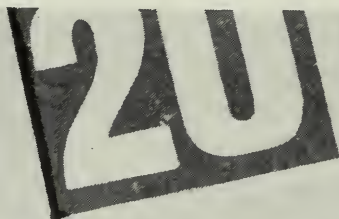
SODIUM PHOSPHATE EXPRESSED

AS $\text{Na}_2\text{PO}_4 \cdot 12\text{H}_2\text{O}$OVER 91.75%

INERT INGREDIENTS

SODIUM CHLORIDE, ETC....UNDER 15.00%

PROCESS PATENT—U. S. PATENT 2020228



BACTERICIDE

A 20% Quaternary Ammonium Chloride

FOR DAIRY SANITATION

Active ingredient: Para-di-isobutylphenoxy
ethoxy ethyl dimethyl benzyl ammonium
chloride monohydrate — 20% by weight.

Inert ingredients: 80% by weight.

IN POWDER FORM

Two examples of labels on disinfectant containers showing contents.

to be the best; many are supposed to be suitable for any and all such purposes. There is no one product that is best under all circumstances nor is there any product without weakness. Despite the large variety of names and packages, all contain one of a relatively few active-ingredients, or one of a few groups of active-ingredients. Under Government of Canada regulations all packages must carry the following information about their contents: (1) the active ingredients, (2) the percentage of active ingredient in the product, and (3) the percentage of inactive ingredient. This information should be considered before disinfecting compounds are bought.

Disinfectants which are to be used on the udders of cows, the equipment coming in contact with them, or with the milk, must be without smell or taste so that they will not produce off-flavours in the milk. This automatically cuts the number of chemicals which can be used to a very few. A list of commonly used chemicals follows:

Sodium Hydroxide

Sodium hydroxide is marketed under two common names—"Lye" and "Caustic Soda". For many purposes it is probably as reliable a cleaner and disinfectant as any that can be obtained. Its main drawback is its corrosiveness or causticity. In strong solutions it can cause unpleasant burns to skin and clothing. In weak solutions it is quite harmless. When solutions are made with hard water a precipitate is formed which can build up on metal or rubber equipment. This fault can be overcome by using only soft or softened water, or by periodic treatment of the equipment with acid milkstone remover. Sodium hydroxide solutions should be made up in enamel, earthenware, crockery or glass containers. They should not be mixed, stored or used in a metal container. Strong or stock solutions can be made and stored ready to be diluted to the correct strength for usage as needed, or sodium hydroxide flakes can be dissolved directly in the proper amount of water for use.

Sodium Hypochlorite

Sodium hypochlorite is the basic ingredient of many common household bleaches and cleaners, is used to purify water supplies by chlorination, and is probably the most widely used chemical disinfectant in the dairy and food industries. Sodium hypochlorite is a most valuable disinfectant, being effective against a very wide range of microorganisms. Since it is rapidly inactivated by organic matter, it should be used on clean surfaces only. This affinity for organic matter is its greatest drawback in the milking barn, because it is necessary to prevent all milk, dirt, cow manure, etc. from getting into the solutions. Provided that this precaution is taken, sodium hypochlorite is probably the most useful, rapid and widely effective disinfectant for the dairy barn and milk house.

Sodium hypochlorite can be obtained in either liquid form or as powder. There are a great many different brands and products containing

varying amounts of the active ingredient. All deteriorate fairly rapidly. Therefore, only a month's supply of disinfectant should be bought at the one time.

Solutions for use are easily made by diluting liquid products or dissolving powders in the requisite volume of water.

Quaternary Ammonium Compounds

A large number of these quaternary ammonium compounds are marketed alone as disinfectants, or mixed with cleaning compounds as cleaner-sanitizers. They have become quite popular in recent years because they are easily manufactured and are non-toxic, almost tasteless and less irritant than some other products. Quaternary ammonium compounds are very effective against certain organisms, but much less so, if not quite ineffective, against others. The group contains many different but related compounds, and this factor of selectivity is one of their main drawbacks in dairy-barn sanitation. Other drawbacks are that they do not penetrate greasy films: like chlorine, are sensitive to organic matter; and are not compatible with highly alkaline cleaners, soaps and many synthetic detergents. Of particular interest from the point of view of mastitis is the fact that they are quite ineffective against *Pseudomonas* organisms which cause certain types of mastitis. Used in combination with other disinfectants quaternary ammonium compounds can be quite useful but, as all-purpose disinfectants they are not satisfactory in the dairy barn.

Products containing these compounds have a variety of names and are marketed by innumerable companies. They can be identified by examining the portion of the label showing the active ingredient. The active ingredient will usually have a very long chemical name ending in "— ammonium chloride" or "— ammonium bromide", e.g. alkyldimethyl benzyl ammonium chloride. If you are doubtful ask your supplier to find out from the maker, or write directly to the maker yourself asking if the product is a quaternary ammonium compound.

Quaternaries are sold both as liquid and powder. Both forms are easily mixed with water to give clear solutions which foam on shaking.

Iodine

Iodine has been used as a skin disinfectant for many years in the familiar "Tincture of Iodine" form. It has, however, had limited use in the dairy barn because of its smell and corrosiveness, and its insolubility in water.

Recently there have appeared on the market a number of compounds of iodine known as "Iodophors" which, as their name implies, contain iodine and phosphoric acid. The name "tamed iodine" has been applied to this form of iodine. They are usually marketed in combination with synthetic detergents as "cleaner-sanitizers".

These compounds have proved to be quite acceptable in the dairy barn, and are rapid in action; effective against a wide range of organisms (some

spore-forming organisms excepted); reasonably non-corrosive; odorless and relatively unaffected by organic matter. Their acid nature prevents the build up of milkstone on dairy equipment.

Iodophore are produced in both liquid and powder form, although the liquid is more usually encountered in Ontario. The liquid is easily measured and mixed with water to form clear pale-yellow solution.

Hibitane

Hibitane, a relatively new organic disinfectant, which was developed in England has been introduced into Canada. It is odourless, tasteless, non-corrosive and has been shown to be particularly effective against Staphylococci and *Str. agalactiae*. Hibitane is not only bactericidal in strong solutions, but it is highly bacteriostatic in weak solutions. It is highly stable in the presence of organic matter. It is rather slower in its killing action than are some other disinfectants. Except in very high concentrations it does not kill *Pseudomonas*, at least not rapidly, but it is reported to prevent multiplication of this organism in reasonably weak solutions. Hibitane is produced only in liquid form, and can at present be obtained only through veterinarians.

The authors wish to express their gratitude to Dr. D. L. T. Smith for much constructive help and criticism in the preparation of this bulletin, and to many others of their colleagues who read and commented on the manuscript.

Pictures contained in the bulletin were prepared by the Photographic Unit of the Extension Department, Ontario Veterinary College, except that showing the use of a strip-cup which is reproduced through the courtesy of Babson Bros. Company, Chicago, Illinois.

The cover was prepared by Mr. J. Taner, Public Relations Department, Ontario Agricultural College, through the kind cooperation of Mr. J. A. Eccles, Director, Public Relations, O.A.C.

IF YOU HAVE A MASTITIS PROBLEM

Control of mastitis can be accomplished only by complete integration of proper diagnosis, expert treatment and enlightened management of the milking herd. Each farm presents a separate problem. This bulletin has been made as comprehensive as possible, in the hope that individuals can review their own particular situations and apply whatever is necessary to them.

If you have a mastitis problem you can be reasonably sure that you need help to eliminate it. The following outline will assist you to correct your trouble:

1. Make a thorough survey of your herd management and correct it where necessary.
2. Pay particular attention to your milking procedure and sanitation.
3. Arrange for a thorough herd diagnosis.
4. Immediately isolate or at least move to the end of the milking line all infected cows.
5. Arrange for adequate treatment of these cows.
6. Dispose of all cows which do not respond to treatment.

Details concerning these various steps may be found by referring to the appropriate sections in the bulletin.

*CARONAF6
B526*

GREENHOUSE VEGETABLE PRODUCTION IN ONTARIO

HORTICULTURAL EXPERIMENT STATION
VINELAND STATION, ONTARIO



ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, ONTARIO

Dr. C. D. GRAHAM
Deputy Minister

Hon. W. A. GOODFELLOW
Minister

CONTENTS

GREENHOUSE ENVIRONMENT	3
Temperature in a Greenhouse, Light in a Greenhouse, The Soil in Which the Plants Grow, Water in the Plant's Surroundings.	
GREENHOUSE SANITATION	10
SOIL STERILIZATION	11
NEMATODES IN THE GREENHOUSE	13
SOIL TESTING	14
How Should a Soil Sample be Taken? When Should a Soil Test be Made? How and Where Should a Soil Sample be Sent?	
CUCUMBERS AS A GREENHOUSE CROP	15
Growing the Seedlings, Temperature, The Soil for the Cucumber Crop, Mulching, Fertilizing, Watering, Pollination, Training, Harvesting, Varieties, Cucumber Diseases, Cucumber Insects, Nematodes.	
LETTUCE AS A GREENHOUSE CROP	21
Growing the Plants, Planting, Temperature for the Lettuce Crop, Watering, Fertilizer, Varieties, Diseases, Insects, Slugs.	
RADISH AS A GREENHOUSE CROP	24
Planting, Temperature, Watering, Soil, Varieties, Diseases, Insects.	
TOMATOES AS A GREENHOUSE CROP	26
Growing the Seedlings, Preparation for Planting, Temperature, Light Conditions and Their Effect, Fertilizer for the Tomato Crop, Mulching, Watering, Varieties, Diseases, Insects.	
PEST CONTROL CHEMICALS	33
Organic Fungicides, Insecticide Aerosols and Smokes, Caution, Bees.	
ACKNOWLEDGMENTS	35

GREENHOUSE VEGETABLE PRODUCTION IN ONTARIO

JOHN WIEBE

*Horticultural Experiment Station
Vineland Station*

In Ontario the winters are sufficiently severe that most plant growth stops completely. Vegetables common to Ontario, are normally killed in September or October. Conditions suitable for the growth of most crops do not return till at least April or May. Some crops have an even shorter period in which they can grow outside. Glasshouses, in which conditions can be controlled, provide an environment in which crops may be grown at any season of the year. The culture of vegetables in glasshouses during the colder months of the year is practical and profitable.

In Europe glass-covered houses are properly called "glasshouses"; in North America the term "greenhouse" is used. Although not strictly correct, the latter term will be used in this bulletin.

Discussion will be limited to the production of a whole crop in greenhouses. The houses are frequently used to start plants in spring for field planting, but that is a separate subject*. The mechanical aspects of the greenhouse will not be discussed in this bulletin because again this is a subject broad enough to justify a separate bulletin. Perhaps the best information on structure is available at present from the companies which specialize in greenhouse construction. As a general rule, even-span houses not narrower than 19 feet and not wider than 50 feet with eaves at least 6 feet from the ground are most practical. The glass should be as wide as practical and the framework as narrow as is safe. Ventilators to allow for the movement of large volumes of air are essential. It is usually advisable to have side as well as peak ventilators in all but the narrowest houses.

Temporary-frame houses covered with plastic materials have been tested and found satisfactory. The initial investment is much lower on these, but there are annual costs of covering and repair. New plastic materials now under test promise to last for a number of years. This will allow cheap construction of a semi-permanent type of house. Production problems will vary only slightly in these houses compared with the more common permanent frame, glass-covered houses.

GREENHOUSE ENVIRONMENT

A greenhouse is a place designed to control the conditions surrounding a plant. The rate at which outdoor plants grow, fruit, and reach maturity depends on the "weather" that surrounds them. This "weather" in its broad sense includes the light falling on the leaves, the temperature of both soil and air, the wind movement, the moisture in the soil and in the air, the nutrient elements available, and the diseases and insects that attack the plants.

In order for a plant to remain alive at all, certain minimum requirements are needed in each factor. For example, in spring all the requirements for growth may be present except that the temperature drops occasionally below the level

* Bulletin 485 of the Ontario Department of Agriculture.

at which a certain vegetable plant can survive. Here temperature is the one condition which limits growth regardless of how favorable all other conditions may be. Outdoors, our control of the conditions surrounding the plant is very limited. We can do nothing about the light intensity or temperature and our control of moisture and nutrition is limited by economic considerations.

In the greenhouse we have a much greater degree of control over the "weather" in which our plants live, although this control is never complete. Because of the cost, artificial light can seldom be added profitably but heat, water and nutrients can easily be added, and the control of pests is possible to the careful grower.

The aim of the greenhouse operator must be to provide the best conditions he can. He must attempt to have growth limited only by the inherited ability of the plant and not by the conditions surrounding the plant. In order to approach this ideal he must know the best level of each factor of the "weather" and then maintain these levels.

Temperature in a Greenhouse

The effect of temperature. The temperature of a plant regulates the rate at which all the life processes proceed. A plant can be compared with a cold-blooded animal which moves very sluggishly when it is cold, moves quickly as it warms up, but is killed easily by temperatures that are too high. Since the plant is not able to control its own temperature the rate of growth is dependent on the temperature in the air and soil around it.

As with the animal example above, each plant has an optimum temperature for growth. This optimum varies from crop to crop. For example, 55 to 60°F. is highly favorable for the growth of lettuce but entirely too low for cucumbers.

Fig. 1 is a diagrammatic illustration of the growth curves of several crops. These growth curves are idealized, but demonstrate that a temperature favorable to one crop may be entirely unsatisfactory for another.

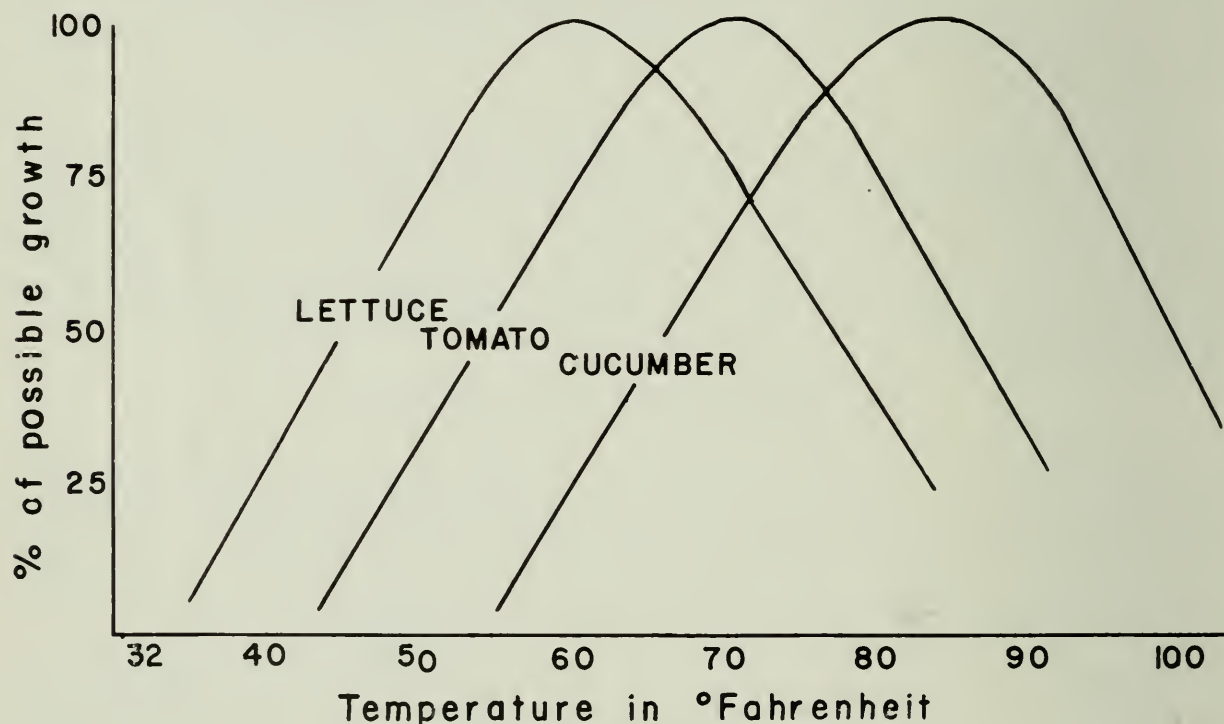


Fig. 1

IDEALIZED GROWTH CURVES FOR SEVERAL CROPS WITH CHANGING TEMPERATURE.

The temperature in a house must not fluctuate too widely from the optimum or growth will be reduced. With temperature changes there is always danger of condensation on the leaves and an increase in leaf diseases.

A plant growing in the light is both making and using food. In the dark it continues to use food but does not produce any. Both the production and use of food are regulated by temperature so it is a useful practice to somewhat reduce the temperature in a greenhouse during the night. In this way maximum production is obtained during the day and is conserved by reducing the night-time use of the manufactured food. If temperatures are kept high at night, or during dull weather, spindly, soft plants result.

By using the lower night temperature a considerable fuel saving results and with actual benefit to the crop.

Care must be taken not to lower temperature too far, even well above the freezing point, at any time or permanent injury may result.

Where does the heat come from? The energy from sunlight shining through the glass of a greenhouse is trapped inside the house and becomes heat. During bright days a very large amount of heat is derived from sunlight, and getting rid of excess heat often becomes a real problem. Even during the shorter and duller days of winter a substantial part of our daytime heating is done by the sun.

Artificial heat must be supplied to the greenhouse, especially at night. Heat must be moved from a source (coal, oil or gas boiler) to the air and soil around the plants. The most common heating system is a coal-fired steam boiler with pipes carrying the steam along the outer walls and above or among the plants. Air moves over the pipes, and carries heat with it, upwards and then among the plants. Many different pipe layouts are used to improve heat distribution. In very wide houses pipes may be led along the house near the ground and away from the walls. Sometimes a portion of the heating pipes are placed above the crop and a few greenhouses are equipped with electric fans to circulate the air and to speed up the heating process. Any system may be used which will uniformly heat the whole house, the choice of a particular system depending on economic and engineering difficulties. No heating system should leave some areas of the house cold, or heat part of the house excessively.

Where does the heat go? Most of the heat loss occurs directly through the walls and glass of the greenhouse. The greater the difference between outside and inside temperatures, the more rapid will be this type of heat loss. In addition to the heat lost by direct conduction there is a large amount of heat carried out of the greenhouse by the air leaving the ventilators. In order to control the greenhouse humidity, ventilation is necessary almost every day. As the air moves through the greenhouse it picks up heat and water and carries both away.

Temperature control. In order to control temperature it is absolutely essential to have a thermometer in each house. The thermometer should be placed at plant level, usually about 3 to 4 feet from the ground. A thermometer in one location in the house tells the temperature at that one place only. Near heating pipes the temperature will be higher, and near the soil or, when the heat is off, near the walls will be considerably cooler than the thermometer shows.

Automatic temperature controls are expensive to install but they relieve the operator of much work and are always "on the job". If automatic controls are not used, the operator must check the thermometer frequently. It is

impossible to "feel" the temperature of a house accurately, so do not depend on how the air feels.

Whether the temperature control is automatic or manual there are still two alternative methods of control: the operator may change the amount of ventilation, or he may change the amount of heat being supplied to the house. In order to reduce humidity and to maintain good carbon dioxide levels some ventilation is necessary, even during the coldest weather. A good rule is to consider the ventilation needs of the crop first and then add heat to maintain the necessary temperature.

Light in a Greenhouse

Light is the primary productive factor in the plant "weather". The wonderful process of photosynthesis by which a green plant changes carbon dioxide from the air and water from the soil into food is powered by light. This most fundamental factor in plant growth is the one which we have least in our control. Artificial light will support photosynthesis but it is economically impractical at present to grow vegetable crops with artificial light. Although it is seldom practised in North America, seedlings for the spring greenhouse crops could be grown with supplemental lighting to get stronger, stockier plants faster.

Normally we must get along with the light we get from the sun. In Fig. 2 we are shown the average hours of direct sunshine per month at Vineland. In areas farther north the curve would be even more extreme. With so little light available during mid-winter, it is easy to understand why it often takes more than twice as long to get a certain amount of growth in January as it does in May. The growth of plants in the greenhouse increases with increasing light during the spring. In midsummer the abundant sunshine makes it almost

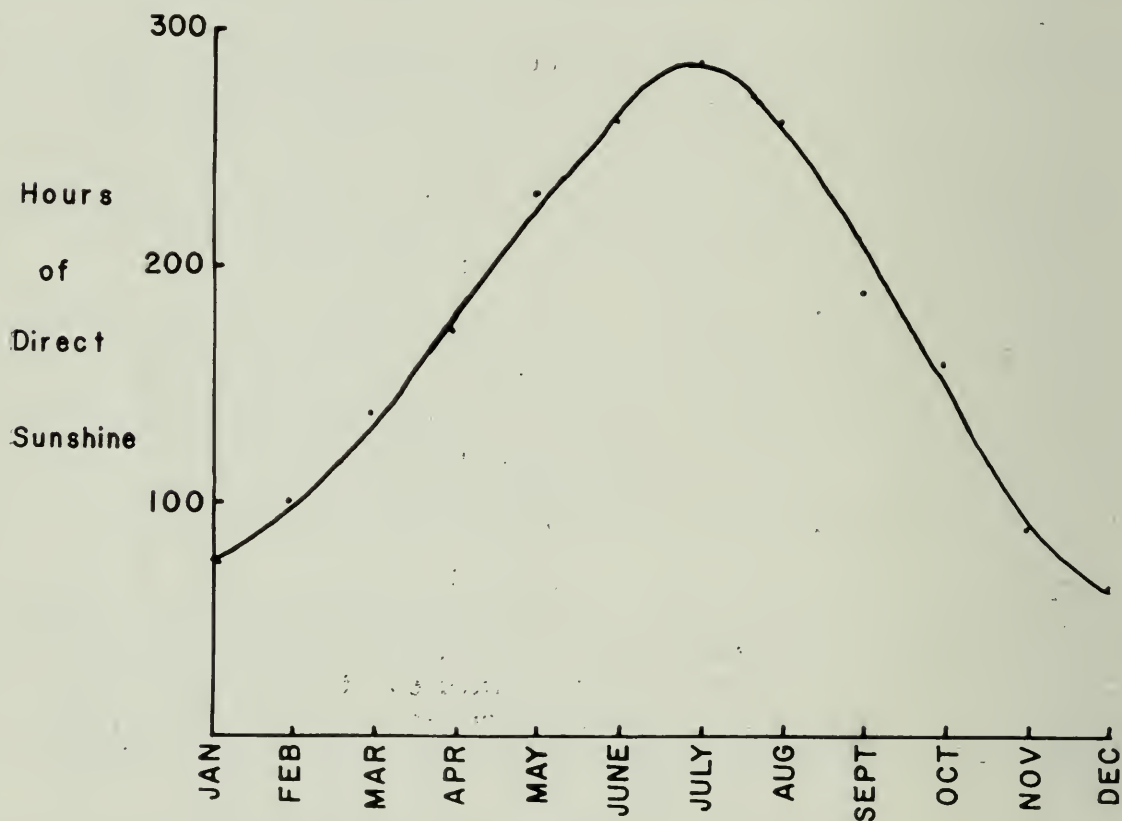
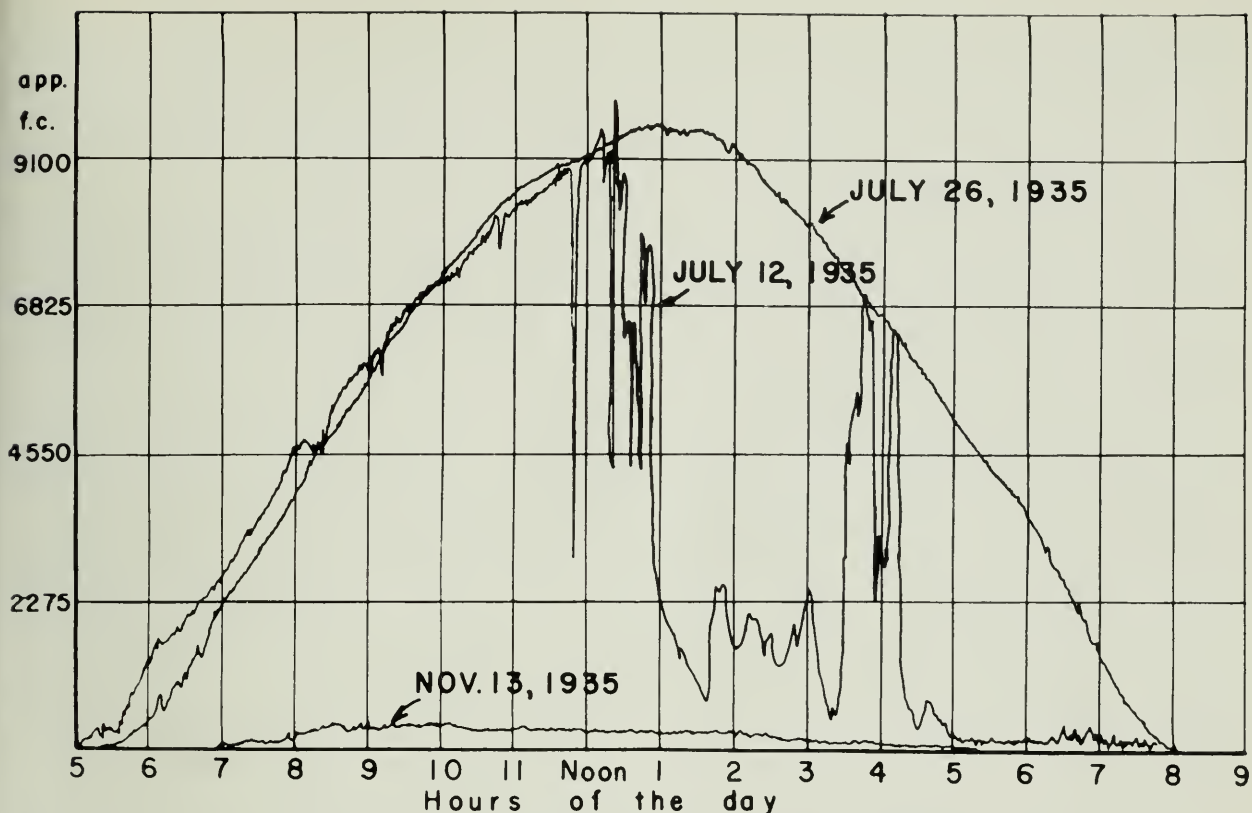


Fig. 2

SHOWING HOURS OF DIRECT SUNLIGHT AS MEASURED AT THE HORTICULTURAL EXPERIMENT STATION, VINELAND STATION, ONTARIO.



From A.J. Heinicke and N.F. Childers

Fig. 3

SOLAR RADIATION ON SEVERAL DAYS AND AT DIFFERENT TIMES OF THE DAYS GIVEN.

impossible to control temperatures in the greenhouse. With excessively high temperatures, growth is again reduced as shown in Fig. 1.

The curves in Fig. 3 illustrate the amount of energy derived from sunlight on three different days. Of the two midsummer days one was cloudless and the other was cloudy in the afternoon. The midwinter day was a dull one and very little useful lighting occurred at anytime during that day.

Since we can do nothing about the light conditions outside the house we must do all we can to let in as much light as possible. Often much light is lost in getting through the house to the plants. Wide clean glass and thin, clean, white framework help tremendously in admitting light with a minimum of loss. The unattainable ideal would be to have a perfectly transparent roof with no framework to throw shadows on the plants.

A great deal has been written about the direction the greenhouse should face to make most use of the available light. During dull weather it matters hardly at all. When the sun is shining an east-west house will get more total illumination but a north-south house gives a more even distribution of the light. Which position is more valuable is largely a matter of opinion.

The Soil in which the Plants Grow

We cannot see the roots as they grow in the soil so it is easy to neglect them. However the root system of a plant is often as large as the top, and must have favorable conditions for good growth.

The first necessity of the root system is room to grow. In a pot or a shallow bench there is a very limited space for root development. When a ground

bench is used, much more root space is available, but even here there are very definite limitations. For vegetable production neither benches nor raised beds are recommended. If there is a layer below the surface that is compacted, wet, or cold, root development is stopped just as effectively as if there were a cement floor in that place. Root growth will seldom be limited in a ground bed if the soil is loose, well drained and warm to a depth of 18 inches.

When benches are used they should be as deep as is practical, and the benches should have drainage holes in the bottom. In ground beds, tile drainage should be installed to insure that all excess water will be carried away. The drainage tile should be laid in a layer of gravel or cinders and then covered with top soil.

Type and Condition of Soil. A greenhouse soil should be a sandy loam with a high organic-matter content if at all possible. A fine-textured or heavy soil tends to compact easily. It also stays wet during long periods of cloudy weather. In contrast, in a sandy soil both air and water move freely and compaction is slight so roots can grow through the soil more easily. Almost any soil can be made suitable for greenhouse production by proper management. Any soil, either in the greenhouse or in the field before being brought into the greenhouse, can be improved by adding organic matter. It should be kept in mind that the organic matter is being added as a soil conditioner primarily, and not so much for its nutrient value. It takes several years to change the condition of a soil, and the addition of organic matter to the soil should be a continuing process.

Both light and heavy soils can be improved by organic matter. Heavy soil is "opened up", that is, made more porous, and very light soil is better able to absorb and hold water and plant nutrients. When the soil is in proper condition it will hold the optimum amount of air, water, and nutrients all at the same time. The organic matter assists greatly in keeping the soil loose and in holding water and nutrients "in reserve" for the plant.

The function of the soil. The main purpose of the soil is to provide a medium in which there is a proper balance between air, water and nutrients. If this balance exists the roots will easily obtain their requirements of water and nutrients, and growth will be rapid.

Water in the Plant's Surroundings

Water may be considered the "lifeblood" of the plant. Every life process is dependent on water. The fertilizer nutrients are dissolved in water in the soil, they are taken into the roots and moved up the stem to the leaves in water. The carbon dioxide from the air is dissolved in water in the leaf and all the chemical reactions go on in the presence of water.

During hot sunny weather the evaporation of water from the plant is the only means by which the plant temperature can be reduced.

A good supply of water at all times is absolutely essential. Any period of poor supply results in stunting and poorer yield. During winter months watering need not be frequent. If too much water is supplied the soil may become soggy and cold. As summer approaches much more water is needed and more frequent watering is essential. The too-common practice of watering every week on a certain day is nonsensical. Water according to the weather and the indications of the crop.

A new instrument, a "moisture meter", is available for estimating soil moisture. In this apparatus a plaster-of-Paris block containing two electrodes is buried in the soil. The electrodes have leads which come up above the soil

surface. The instrument itself when attached to the lead wires measures the electrical resistance between the electrodes. When the soil is moist, the plaster block becomes moist and the resistance between the electrodes drops. As the soil dries the resistance increases. Blocks can be located throughout the house and one meter used periodically on them all.

Water is present in the air around the plant as well as in the soil. By maintaining a high humidity in the air the water loss from the leaves is reduced and growth improved. With high humidity the danger from leaf diseases is increased. Ideally a relative humidity range of 75 — 90% should be maintained.

Plants are frequently sprinkled during sunny weather to reduce their temperature and to increase humidity. Care must be exercised that plants do not go into the night wet or serious disease outbreaks may occur. In winter months water before 11 A.M. to be sure the foliage will dry by nightfall.

If dull cold weather persists for several days the humidity will rise to dangerous levels. Under these conditions ventilate the house and increase the amount of added heat.

GREENHOUSE SANITATION

The principle has been established that all life must come from pre-existing life. Most of our disease and all insect problems are caused by living organisms and each of these comes from an organism of its kind. If we get mildew on a crop it is only because mildew spores are present, and fall on the crop. Even if our plant is susceptible to a disease, it will not become affected unless the disease organism can reach the plant.

If we could control perfectly the environment in which we grow plants, we could exclude most insects, bacteria, fungi, viruses, and nematodes. Our control over the environment is not perfect, but we can do much more than is usually done.

Particularly on small establishments many plants are allowed to grow near the greenhouse. Often weeds grow rampant right up to the wall of the greenhouse. These plants make a wonderful haven for the various insects that regularly invade the greenhouse. Aphids, thrips, mites, and fleabeetles will live on many plants and will move through ventilators into the greenhouse. A number of diseases, but most notably the viruses, live in weeds or crop plants and are readily carried into the house by these insects. Viruses move in most frequently with the aphids. An aphid sucks juice from an infected weed, then moves into the house and inoculates the crop plants. All growth except grasses should be eliminated from the immediate vicinity of the greenhouse.

Most pests survive between fall and spring crops right in the house itself. Bits of foliage left lying around or hanging on the wires are enough to start an outbreak immediately the new crop is planted. Insects can hide under any bit of rubbish and survive till new food is planted for them. It is no accident that the neatest houses are often the ones where insects and diseases are not serious.

It is often necessary to grow various crops in the same greenhouse or range of houses. Many pests can attack a wide range of plants. If there is a continuous supply of plants it is almost impossible to prevent movement of pests to the young plants. Crops should be separated as much as possible. If a group of plants in a house is known to be affected by some pest, try to prevent men moving from the affected to the clean areas. If possible, have one man work the affected plants just before the end of a working day, and have him clean his clothes and hands before returning to work among clean plants.

If a small infestation of a serious pest occurs, removal of those plants is often justifiable. In some cases increased dosages of a control chemical, even if some plant injury occurs, will ensure eradication of the pest.

If a crop has been seriously affected by some disease or insect it is advisable to use measures which will clean the walls of the house, wires, stakes and even plant containers after the crop has been removed. Drenching with the appropriate insecticide or fungicide can be of benefit in reducing the severity or eliminating the disease or insect in the following crop.

SOIL STERILIZATION

Soil sterilization is really an extension of sanitation below the ground surface. Most organisms can live in the soil for a short period of time and some live in the soil exclusively. The most common greenhouse pests living in the soil are fusarium and verticillium wilt fungi, and nematodes. Insects, weed seeds, some bacteria, many fungi and a few viruses though less important are still troublesome pests which sometimes live in the soil.

What is known as "soil sterilization" is really only soil "pasteurization" since several types of organisms usually survive the common methods of treatment. Fortunately all of the common greenhouse pests are killed fairly easily by heat and by some chemical fumigants. The most frequent cause of unsatisfactory results is failure to treat the whole volume of soil in which the plants grow. Near walls, walks, or support posts it is difficult to apply the sterilization treatment and often a few pests survive. These spread with amazing speed through the freshly treated soil which has just been freed of all competition.

The most common and most nearly foolproof method of soil sterilization is with steam. Steam is used to heat the soil until all common greenhouse pests have been killed. A reasonable recommendation is to heat the soil to 180°F. and then maintain that temperature for 1 to 2 hours. Slightly lower temperatures and shorter heating periods will kill practically all pests but this recommendation will ensure thorough sterilization. Do not heat longer than necessary. Many growers bury a potato in the soil; when the potato is cooked they shut off the steam. This is a good measuring device, but a good soil thermometer is more reliable. A dial thermometer with a long probe is acceptable but perhaps the best type is a special soil thermometer with several feet of cable so the sensitive element may be buried at a considerable depth and the dial be placed where it can be read easily.

The most efficient steaming technique is through a permanent tile system. Tiles are laid about 12 to 14 inches below ground and not more than 18 inches apart. Steam is forced into as many rows of tile at one time as the boiler will carry. If the soil is covered with straw or with a tarpaulin, it can be heated to 180°F. at the surface in about 1 hour. To assure thorough heating the steam should be left on for 1 hour more. When the steam is turned off the soil will stay above 180°F. for at least one more hour. In this way the soil should be freed of all pests to a depth of at least 18 inches.

Several types of steam injectors and inverted "pans" have been used. These can give satisfactory results but are usually less efficient and more awkward than the buried tile. Even with injectors, steam seldom enters the soil to a great enough depth, so it is common to get incomplete kill of soil pests.

Recently more growers have steamed their soil from the surface by releasing the steam through perforated pipe or porous hose under a plastic cover. The bulb of a thermometer is buried at 12 to 15 inches and steaming is continued till this thermometer shows 180°F. for half to 1 hour. In coarse soil this method has proven satisfactory. It has the advantage of being easy to use and in this type of soil tile is usually unnecessary for drainage. The disadvantage is that more heat is needed to sterilize the same volume of soil since much heat is lost through the plastic cover.

Chemical treatment is not a new technique but new materials are now available that make this a practical method of soil sterilization. Formerly formalin or chloropicrin were used, but these materials have serious disadvantages. Methyl bromide, ethylene dibromide (EDB), or dichloropropene-

dichloropropane (D-D) mixtures are effective. Methyl bromide is a gas which leaves the soil quickly. The other two materials are liquids and take longer to leave the soil, so planting must be delayed a minimum of 10 days after treatment. If soil and air temperatures are low after treatment, two weeks or more must be allowed before planting.

When using materials that are liquid, injection into the soil is necessary. Several types of injectors are available that will place a measured amount of material to a depth of 6 to 8 inches below the surface. It is usually advisable to cover the surface with a tarpaulin for at least 24 hours after treatment.

When using a gas like methyl bromide, application is at the surface under a gas-tight cover. A plastic sheet is placed over the area to be treated. The edges of the sheet are covered with soil and the material is released, out of the pressure can in which it is purchased, through a thin tube and under the cover. The gas penetrates the soil satisfactorily.

Particularly where there are no steam facilities, chemical treatment is of high value although none of the chemical treatments is as consistently reliable as steam. The treatment is no more expensive than steam under most circumstances. Since no expensive or awkward equipment is needed and no special training is required, this method is suitable for small growers. Methyl bromide is highly poisonous and must be used very cautiously. All the manufacturer's directions should be followed carefully.

Regardless of the method used for sterilizing the soil, it is desirable to have the organisms in the soil in an active condition. For at least a week before treatment the soil should be warm and moist (as if growing plants). This encourages the organisms to change from the tough resting stages to the active and susceptible form.

NEMATODES IN THE GREENHOUSE

Nematodes are tiny, worm-like animals which live in the soil and attack the roots of many plants. One of these, the root-knot nematode, often becomes very serious in greenhouse soils attacking such crops as tomato and cucumber. The root-knot nematodes live within the root, feeding upon the cells. They cause the roots to become very swollen and distorted resulting in the familiar root knots. (See Fig. 4).

The nematodes reproduce within these knots and the young move through the root tissues or through the soil to another plant, thus spreading the infection.



Fig. 4

ROOT-KNOT NEMATODE INJURY ON GREENHOUSE TOMATO.
(COURTESY OF DR. W. B. MOUNTAIN, SCIENCE SERVICE
LABORATORY, HARROW, ONTARIO)

Above ground, the infested plants often are wilted, and in severe infections the plants are stunted and may even die. Usually root-knot starts in small isolated spots in the greenhouse, perhaps where the steaming was not very effective, or near a door-way where some infested soil has been carried into the greenhouse, and the area of affected plants slowly spreads from these spots.

Soil sterilization by steam or chemicals is used to control this pest (see Page 11). Nothing can be done to control the nematodes while the crop is still in the ground. If the infection is not too severe, the life of the plant can sometimes be extended by mounding the plants to stimulate the production of new roots.

SOIL TESTING

How Should a Soil Sample be Taken?

Since only a little soil can be sent in for test, it is important that this small amount really represents the composition of all the soil in the area to be tested. Take a number of samples in each house, or section of a house, and bulk them. Then mix these sub-samples and take out the amount to be sent away. If the house is small and uniform one composite sample should be enough. From a large house several samples from different parts of the house should be sent. Approximately the same amount of soil should be included from all depths down to 12 inches.

The final sample to be sent in for analysis should weigh between one-half and one pound.

Circular 181 "Help Yourself to a Soil Test" is available free from the Ontario Agricultural College at Guelph. This gives detailed instructions on soil sampling.

When Should a Soil Test Be Made?

It is advisable to have a soil test made immediately after the preparation of a house for a new crop, or if any trouble is noted in the house. During the growing period, soil tests should be made at about four-week intervals. It usually takes about two weeks to get results back to the grower, so it is important to send samples in as quickly as possible after any disturbance or after any abnormality is noticed.

How and Where Should a Soil Sample be Sent?

The samples should be put into a clean rigid container that can safely be sent through the mail. The Department of Horticulture will send self-addressed containers on request. Packages must be clearly marked as soil samples and addressed to:

DEPARTMENT OF HORTICULTURE,
ONTARIO AGRICULTURAL COLLEGE,
Guelph, Ontario.

To help the specialist making the fertilizer recommendations, the following information should be sent with the samples:

1. The cropping history of the house from which the samples were taken.
2. The crop that is to be grown, or is now growing.
3. What cultural practices (soil sterilization, manure, or lime additions etc.) have been used and what is planned.
4. Any unsatisfactory condition in the previous crops.
5. The fertilizer application which you plan for the crop.

With this information it is much easier to interpret the results of the chemical test and make intelligent recommendations.

CUCUMBERS AS A GREENHOUSE CROP

The cucumber is a semi-tropical plant growing best under conditions of high temperature, high humidity, high light intensity, high moisture supply and high nutrient level. If these conditions prevail, and if insects and diseases are controlled, growth is amazingly rapid and a large volume of fruit can be harvested. However, cucumbers are highly sensitive to unfavorable conditions. Each growth factor must be carefully controlled because levels only a little different than the optimum can cause marked reductions in growth and yield.

Growing the Seedlings

The soil should be well sterilized (see Page 11) before seeding and the seed treated with an organic fungicide to reduce damping-off.

Since cucumbers transplant poorly they are grown from seed in pots. One or several seeds are put in each pot. If there are several seeds per pot, as soon as the young plants are well established, all but one plant per pot are pinched off.

Plants growing in the pots should be kept at about 80°F. and should not be shaded or crowded. Proper lighting and temperature encourages sturdy plant growth. Crowding results in spindly, brittle growth which adds to planting difficulties.

Temperature

Cucumbers will grow best at temperatures between 80°F. and 85°F. when there is plenty of sunlight. During dull weather a range about 5° lower should be used. Night temperatures can be dropped as much as 10° below those used the preceding day but should never drop too low. If low temperatures (50° — 60°F.) are used for any length of time the plants become hardened and make very little growth. Active growth must be maintained to ensure a continuous set of fruit.

The Soil for the Cucumber Crop

A very open soil with an exceptionally high organic-matter content is best. Cucumbers suffer quickly from poor aeration, yet require a constant large supply of water. The soil which best can provide these conditions is a sand with at least 10% of fine incorporated organic matter. Coarse straw, or other material which has not broken down, helps soil condition only slightly, even though it is good as a mulch. Fresh organic matter added to the soil can cause nitrogen deficiency in the crop. This is due to increased bacterial activity. The bacteria deplete the soil nitrogen rapidly. Soil test will not always indicate this quickly enough but it will be evident from plant response and foliage symptoms. The ideal soil is usually the result of adding organic matter over a period of years and working it in after each crop. Corn stalks or straw which are often used to prevent compaction of soil on the walks are ideal for this.

The soil should be well worked and, if desired, ridges can be built before planting. Once the soil has been loosened, to prevent compaction you should not walk on it any more than necessary. A naturally hard or compacted soil will reduce the rate and amount of growth. The plants may not show any sign of being unhealthy yet will be low in yield.

Mulching

Mulching the soil in the cucumber crop serves several purposes. The mulch will reduce evaporation of water from the soil, the temperature fluctuation in the soil and also soil compaction. Later when the mulch is worked into the soil it helps materially in increasing the soil organic-matter content.

Manure is often used as a mulch since it has the additional advantage of acting as a fertilizer. It is not nice to walk around on manure all the time and it tends to become compacted. Straw or corn cobs, in contrast, remain reasonably loose and dry at the surface. Mulching alternate rows with manure and the others with straw or cobs allows workers to walk on dry, clean mulch while giving the plants some manure.

Fertilizing

As mentioned, the cucumber is a very heavy feeder. A constant high level of nutrition is necessary.

As part of the soil preparation manure (as much as 70 tons per acre on poor soil) and some fertilizer should be worked into the soil. The amounts of fertilizer to be added can only be found by soil test. In very rich soils it may not be necessary to add any fertilizer, and only moderate quantities of manure are needed.

Chemical fertilizers of various types are used throughout the growing season to balance the nutritional status of the soil and to make rapid adjustments. Superphosphate at 20 to 25 pounds per 1000 square feet can usually be added as a preplanting treatment. If potassium is known to be low, potash salts can also be used at that time, at about 15 to 20 pounds per 1000 square feet. Once the soil has been prepared and the crop planted, soil samples (see Page 14) should be taken at regular intervals to follow the level of the major nutrients.

During the growing period it is difficult to add phosphorus in such a way that it will become available to the plants. Potassium can be added as muriate of potash. Nitrogen is most easily fed, since it dissolves completely and moves freely in the soil.

Completely soluble fertilizers of many types are now available. The necessary nutrients can be dissolved and then dumped into the watering system. In this way the fertilizer can be applied easily and in a form which is immediately available to the plant.

Both phosphorus and potassium levels in the soil change slowly, so by a series of soil tests the grower can keep track of them. Nitrogen levels vary sharply in a short time. If there is a week of dull weather and the soil is kept warm, the rotting manure releases more nitrogen than the plants can use. If this is followed by some very bright weather, the plants will grow very quickly, and in a week's time a nitrogen excess in the soil will have been completely used up, and in another week a definite deficiency can exist. For this reason the greenhouse operator should watch his plants for deficiency symptoms. If the leaves become uniformly pale, nitrogen starvation is indicated. It is possible to estimate by the weather of the past several weeks whether the use of nitrogen has been high or low and thus predict the needs. Because of the rapid changes in nitrogen level particularly, soil tests alone are not fully adequate.

Because a large amount of fertilizer is used on cucumbers, there is a definite danger of overfertilization. Cucumbers need a high nutrient level but are quickly harmed by too high a fertilizer content in the soil. The only way to know for sure is to have a soils laboratory conduct a "soluble salts" test. If readings of 120 or more are returned to you, it is wise to apply additional fertilizer very carefully and not too liberally. If readings are 150 to 180 or higher some heavy watering is necessary to wash some salts down the tile drains, and if readings are over 200 leach very heavily for a few days.

The indications of high salt levels in the crop are a dark green colour of the foliage and temporary wilting during bright sunshine even when the soil is moist. Considerable reduction in yield may occur before any serious plant symptoms are noticeable.

Watering

It is desirable to keep moist at all times the soil in which cucumbers are growing. Occasional heavy waterings are needed to insure that water is penetrating the whole root zone. If only frequent light watering is practised, roots will tend to stay in the upper layer of soil, thus restricting the root area.

If at all possible the water used should be warmed to near room temperature. Cold water will almost completely stop plant growth until the moist soil warms up again.

During the bright warm spring and early summer days, it is a common practice to moisten the foliage and the soil surface to increase the humidity. This sprinkling is effective in reducing water loss from the leaves and lowering the temperature. High humidity and wet foliage will tend to increase both *Botrytis* and *Sclerotinia* and may increase mildew. The grower must always "ride the fence" between the two evils. As a general rule, wet the foliage only when the temperature is rising, not in the late afternoon when it is falling. Do not let plants stay wet too long at one time and attempt to keep humidity at moderate levels.

Pollination

Sexual reproduction in plants depends on pollen from a male flower or part of a flower being transferred to a female organ. In tomatoes, with male and female parts close together in the same flower, self pollination occurs fairly easily when plants are disturbed or vibrated. Cucumbers have male and female organs in separate flowers of the same plant so pollen must be transferred from flower to flower. Outdoors, insects perform this service, but during the winter and in the greenhouse there are normally no pollinating insects present.

Hives of honeybees are frequently placed in the cucumber house or just outside with the hive entrance joined to the house itself. A strong active hive will effectively pollinate several thousand large plants. For the bees to work well they must have young brood in the hive and they must have good conditions. Bees will not work the flowers when they are wet, or when the air in the house is "musty", so for a period in the morning of each day everything should be left dry. During the spring and early summer, it is often necessary to sprinkle the plants to cool them and to raise the humidity. If this is done all through the day the bees will not visit the flowers. If this is continued for several days, there may be some difficulty in getting the bees to work the flowers even when favorable conditions return. Normally, most cucumber varieties will set some fruit parthenocarpically (without pollination). Such fruits are without seeds and of high eating quality. However, at the present time there are no commercially acceptable varieties available that will set a profitable crop without the benefit of bees.

Hand pollination is possible but too expensive.

Training

The plants are trained upwards along a thin stake, or along a cord tied to a network of wires about 6 to 6½ feet above the ground. Only one main stem is brought up to the top of the stake or cord but then the plant is allowed to

branch somewhat and spread horizontally. When a branch starts growing at a leaf axil it is usually pinched back at the second leaf. In this way the lateral branches also produce fruit without getting too big. Occasionally, if the top growth becomes too heavy, plants are pruned down severely and a new shoot from a few feet above the ground is trained upwards. Training must be designed to keep new growth coming continuously but not to let a "jungle" growth develop.

Harvesting

Cucumbers are picked as soon as they are well developed for eating purposes. The fruit should be well filled out, but should be picked immediately it reaches this condition. Usually a fruit 8 to 9 inches long and about 2 to 2½ inches in diameter is considered to be the right size. If fruits are left on longer for any reason they will tend to prevent fruit setting on new flowers.

Any misshapen or damaged fruit should be removed as soon as it is evident that it will not develop normally.

Varieties

Although almost any variety will produce fruit, some do not produce the type and quality of fruit desired. Burpee Hybrid is by far the most popular variety in Ontario for greenhouse production. This variety produces fruit of the right size and with a moderately dark green colour. The plants are highly vigorous.

Several new varieties, both hybrid and open-pollinated, are being grown in limited quantities. At present there is none that is good enough for general recommendation.

There is a very limited market for the long smooth English types like Telegraph. They are not acceptable to most buyers at present, though the quality is excellent.

Cucumber Diseases

Powdery Mildew. This is the most serious disease of the greenhouse cucumber crop. At first, small snowy-white spots appear on the upper surface of the leaves. They quickly spread in size and to other leaves. Under conditions favorable to the disease, the spread is rapid. An affected leaf soon is completely covered with a fine powdery coating which produces multitudes of spores. These spores are carried to other plants by air currents and on the hands and clothes of workers.

Chemical control of mildew is possible. Karathane as a spray (6 oz. per 100 gallons, thoroughly sprayed on all leaf surfaces) or as smoke aerosols will slow or stop the spread of the disease. Treatment should be at weekly intervals on serious infections and at two-week intervals where only a little mildew is present. Proper sanitation and adequate ventilation should be used even where a chemical treatment is used.

Mosaic. Some of the same strains of virus found on tomatoes and on flower crops also infect cucumbers. The affected leaves are dwarfed and frequently "cup" or become long and narrow. The veins lose colour so there is a network of clear tissue with the blade between the veins taking on a very dark green colour. Fruit that is affected is usually misshapen and the surface is checked and rough.

Mosaic was once a very prevalent and destructive disease but with the use of mosaic-resistant varieties such as Burpee Hybrid this disease is no longer a serious problem.

Wilt. Usually wilt is caused by *Fusarium*, a soil-borne fungus. Where soil sterilization is regularly practised, this disease is not common. Occasionally, serious outbreaks occur in new houses or even in an older house that has been sterilized. Even new soil may carry the disease. Since *Fusarium* can grow on a wide range of plants, fresh soil from the field, but particularly from garden plots, may have *Fusarium* in it. If this soil is used directly in the beds or in the pots to grow the young plants, the disease may become serious. Someone who has carefully steamed his beds but not his potting soil or his pots has wasted steam.

Foot-rot. This is a disease complex, made up of several organisms, which is particularly severe in crops planted early in the year when growing conditions are poor. In unsteamed or poorly sterilized soils several fungi attack the roots and base of the plant causing a rot. The affected area usually becomes brown and woody. Often plants survive but do not produce full crops.

Proper sterilization of pots, potting soils and ground-bed soil controls this disease.

Sclerotinia and Botrytis Rots. These two organisms live on dead or dying tissue mostly but will invade healthy tissue if conditions are just right. The organisms gain entry at the site of wounds or injury on the plant provided there is enough moisture in the air and on the plant for them to grow. Adequate ventilation helps very materially in reducing the spread of these rots. Infected areas may be covered with a fungicide paste (usually Ferbam).

Cucumber Insects

Two-spotted Mite (Red Spider). This is the most destructive pest of the cucumber crop. The mite itself is just barely visible with the naked eye but the results of its feeding are quickly evident and almost unmistakable. Mites usually feed on the underside of the leaf causing white speckled areas to appear where it has been feeding. Severe attack will cause paling and later browning of the leaf. Feeding consists of piercing the cells of the leaf with a hollow tube-like mouth and sucking out the cell contents. Usually the attack begins near the attachment of leaf blade and petiole, then spreads as the mites multiply.

Several organic insecticides will control mites, but some leave residues poisonous to humans. Dithio smokes or aerosols or TEPP aerosols usually give effective control. If infestations are heavy weekly applications of TEPP or three treatments with Dithio at three-day intervals are recommended. For light infestations or when mite development is slow, treatment every 10 to 14 days may give satisfactory control.

Greenhouse Whitefly. This insect occurs more frequently than any other but is not usually as damaging as mites. Under favorable conditions the whitefly multiplies very rapidly. When many of the immature insects are present on the undersides of leaves they secrete a sticky deposit on the foliage and fruit. The sooty fungus which grows in this deposit often discolours the fruit and lowers the grade.

The whitefly can be controlled by the regular use of Dithio or TEPP material which is used for mite control. If control is not obtained with these materials a spray of Perthane will usually be effective.

Thrips. These insects occasionally invade a cucumber crop. Although not often found, they can cause serious loss when they do occur.

Thrips feed by rasping the leaf surfaces and sucking the plant juices. The plant tissues around the damaged area dry out and appear as a white papery spot or streak.

Applications of Dithio or TEPP, as used for whitefly, mite or aphid control are recommended. Lindane as a spray is excellent for thrips and aphid control.

Aphids (plant lice). Several species of aphids will feed on cucumbers. As with other crops, aphids not only damage by direct feeding but also spread virus diseases. The insects themselves are large enough to be easily seen. Colour varies from pink and yellow through all shades of green. Feeding injury appears as a puckering, stunting, and curling of the leaves.

Again, repeated applications of Dithio or TEPP in various formulations give control. It is advisable to apply the insecticide even when only a few aphids are present because of their extremely rapid reproduction.

Nematodes. (See Page 13).

LETTUCE AS A GREENHOUSE CROP

Lettuce is a cool-season crop.

Unlike cucumbers or tomatoes, the lettuce crop is grown for its leaves, not its fruit. When the crop has reached a marketable size, the whole top is removed. In this way a crop is in the greenhouse for only a short time and several crops may be grown in one season. Harvesting is a one-time operation considerably reducing the cost per unit-area of space.

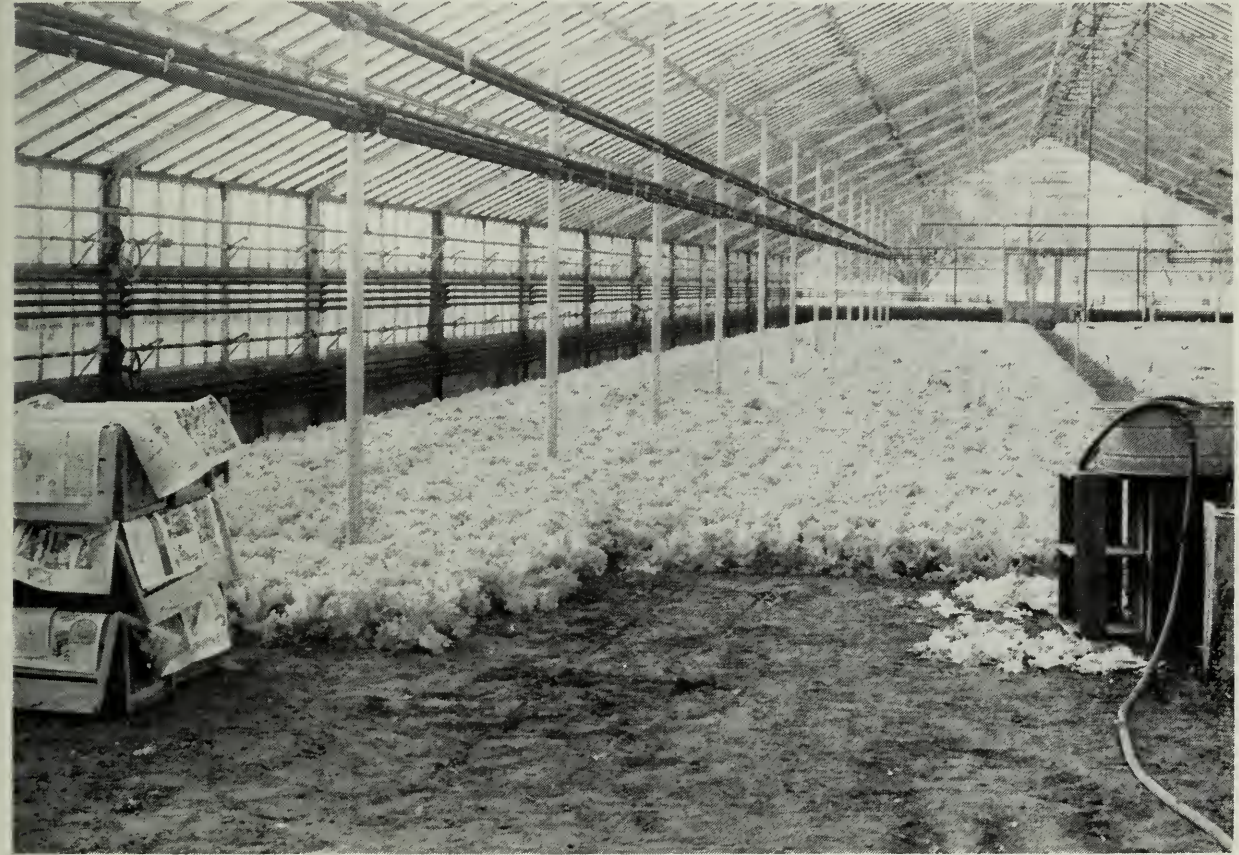


Fig. 5

A MATURE LETTUCE CROP BEING HARVESTED.

Growing the Plants

It is possible to seed direct into the soil and later to thin the plants. More commonly to save space, lettuce is seeded in flats or beds and transplanted as soon as it has leaves one-half inch long. The transplanting is usually into small clay pots, into plant bands or into beds. When the plants are about $2\frac{1}{2}$ inches tall they are placed in the permanent beds. Conditions for the growing of the plants are very similar to those for growing the crop itself.

The length of time to mature a crop will vary greatly with temperature and with light conditions. This makes it impossible to set a time schedule for the various operations.

Planting

Usually the plants are placed very close together. Spacings from as wide as 9 x 9 inches down to as close as 6 x 6 inches are used. With the very close spacing, individuals are somewhat smaller and more labour is required, but

total yield is higher. Since leaf rather than head lettuce is grown almost exclusively, plant size is of minor importance.

Temperature for the Lettuce Crop

Lettuce grows well if it never gets warmer than 70°F. A daytime temperature of about 60°F. and a night temperature of 45-50°F. will give good growth. If high temperatures occur even for a short time, "burning" of the leaf tip or margin may result. Adequate ventilation must be practised to keep the soil surface and lower leaves dry; otherwise rot may do a great deal of damage. Ventilation for temperature control is also necessary whenever there is bright sunshine. Although lettuce can be damaged by very cold air it is not as sensitive to draft as a crop like cucumber.

Watering

Lettuce plants have a fibrous root system which does not penetrate very deeply. If a large amount of water is added at one time much of it will pass through the soil and be lost. Fairly frequent, uniform, moderate applications should be made for best results. If the edges of the house dry more quickly, spot watering to maintain uniform moisture is advisable. Watering should be done so the surface of the soil is wet for as short a period as possible. Splashing soil onto the leaves will increase rot problems and make more work in preparing the product for sale. It is customary to stop watering when the plants touch between the rows.

Fertilizer

Lettuce is a poor feeder so a fairly high level of nutrition must be maintained even though the plant is taking up only a part of what is available. If a good level of nutrition already exists, 30 to 40 pounds of 5-10-15 per 1000 square feet worked into the soil just before planting will give good growth. After the plants are established, a moderate nitrogen sidedressing will give lush and rapid growth.

Varieties

The most widely used variety is Grand Rapids. Practically all the lettuce grown is of this variety in its several strains. The variety Grand Rapids is vigorous and produces an attractive, rather pale plant. Some butterhead-type lettuce is grown but the market is limited.

Diseases

Damping Off. Treat the seed with a fungicide (such as Thiram or Arasan) Sterilize the pots and flats and use only well sterilized soil for growing seedlings. If the disease gets started, a fungicide may be spread on the soil surface. Keeping the soil surface as dry as possible is helpful.

Bottom Rot. The older leaves or the base of the stem develop a soft rot. As with damping off, soil sterilization and disinfection of pots or flats will be of most help. Treatment of mature plants with chemicals is almost impossible. The disease develops most during moist cloudy weather. It is important to ventilate as freely as possible when this type of weather persists while watering as seldom as possible.

Insects

Aphids. Even small populations of aphids on lettuce are very objectionable to the consumer. Complete control is necessary. Nicotine, or Dithio smokes or aerosols, applied as soon as any insects are noticed, and repeated at about 1-week intervals, will give control. For effective control, temperature in the greenhouse should be 70-75°F. during treatment.

Slugs

Occasionally slugs may become troublesome, particularly where sanitation is not good. Clean up the greenhouse and remove old flats, pots etc. which provide hiding places. The slugs thrive on the tender lettuce leaves and can easily hide under the plants. Commercial metaldehyde bait spread near, but not touching the plants will give some measure of control.

RADISH AS A GREENHOUSE CROP

Like lettuce, radish is a cool-weather crop. Growth is very rapid except in midwinter, so a number of crops can be harvested during one growing season. It is sometimes possible to grow a crop of radish between the rows of tomatoes (while the tomatoes are still small). Since the tomato crop is the more valuable one, the temperature should be maintained to suit tomatoes. This will be a little warm for radish but satisfactory results are possible.

During the late spring with long bright days, a radish crop may be harvested three weeks after seeding. In midwinter, a much longer time will be needed.

Planting

Radishes are seeded directly where they are to grow. Seed may be broadcast but is usually put in rows three to six inches apart. Plants in the row are thinned to about one inch apart.

Temperature

Ideal temperatures for radish are a little higher than for lettuce but lower than for tomato. Recommended daytime temperatures are 60 to 70°F. on bright days, 55-60°F. on dull days with a night temperature of about 55°F. If higher temperatures are used during dull weather a leggy, thin, undesirable growth results.

Watering

The soil should be well moistened just before seeding, and the surface kept moist until the plants are up. During dull weather, overwatering results in heavy top growth and poor roots. Water consumption is not very high with the radish crop but, to encourage smooth roots and uniform rapid growth, an adequate supply is necessary all the time.

Usually radishes follow a crop that has been well fertilized. If this is the case only very moderate amounts of additional fertilizer are needed. On an average soil without fresh manure 10 to 15 pounds per 1000 square feet of 5-10-15 can be added. Extra nitrogen, after the crop is up, should be added only if nitrogen deficiency is indicated by pale foliage. Excess nitrogen results in large leaves and small poorly developed roots.

Soil

This crop requires a fairly high proportion of sand in the soil. A lumpy or heavy soil quickly results in misshapen roots. Shape of the root is important so if radishes are frequently grown the soil should be as sandy as possible.

Varieties

Most radish varieties will grow fairly well under greenhouse conditions. Within any variety there are usually "forcing" strains which are particularly adapted to greenhouse or coldframe culture. The choice of a variety depends largely on the preference of the market being served and on performance under local conditions.

Various strains of Early Scarlet Globe are most widely used. In most markets a bright red round radish is preferred.

Radish seed that has been separated into different sizes is available. This helps to give a uniform germination and tends to uniformity of root size. In

this way a greater proportion of the roots will be marketable at one time. The seed should, of course, be of good quality and have a high germination percentage.

Diseases

Under most conditions, there are no disease problems in greenhouse radishes. Usually, before any disease has become serious, the radish crop is ready to be harvested.

Insects

Aphids are the most common insect problem in radish. If the house is kept clean (see sanitation Page 10), the aphid population should not build up quickly enough to be serious by harvest time. A small aphid population is not as serious on radish as on lettuce.

Under warm dry conditions aphids may be troublesome. If it is necessary to use chemical control, nicotine or dithio, smoke generators may be used.

Fleabeetles will occasionally enter the house if the radishes are being grown during the outdoor-production season. The beetles injure the plants by eating holes in the leaves. DDT applied as a dust, spray or aerosol will control this insect. Treatment in the greenhouse will have little effect if more beetles enter from outside. This insect is rare if no crop on which the beetles feed is near the greenhouse.

TOMATOES AS A GREENHOUSE CROP

Tomato is the most widely planted vegetable crop grown in greenhouses in Ontario. The crop is grown in fall or in spring. Conditions and problems vary for the two crops. The fall crop is seeded and planted while there is high light and temperature and matures during the short days of late fall and winter. The spring crop is seeded during the low-light part of the year, grows slowly during its first several months but matures under the very favorable light conditions of spring and early summer.



Fig. 6

TOMATO PLANT TIED TO A STAKE AND SHOWING
METHOD OF PRUNING COMMONLY PRACTISED.

Growing the Seedlings

Most greenhouse operators grow their own plants. This is a desirable practice since it reduces the possibility of bringing in disease or insects from elsewhere. It is important to plan well in advance so that everything will be ready when the proper seeding time arrives.

In deciding when to seed, the desired harvest time should be considered. It takes about 4 to 4½ months from seed to first pick in the normal fall and 5 to 5¼ months during the normal spring. If a fall crop is being grown to start ripening fruit the first part of October, seeding should be done about the middle of June. For a spring crop to come into production in April, seeding must be done before the end of November. Often a spring crop is seeded in December.

The seedlings are best grown in rows in a flat and should be transplanted as soon as the cotyledons (seed leaves) are fully expanded. It is best to transplant each plant into an individual container, either a 4-inch clay pot or some other container of similar size. The plants should grow in these until they are about

6 to 8 inches tall and then be placed in the greenhouse in their final location. Do not, under any circumstances or for any reason, harden greenhouse plants but, on the other hand, do not force a soft spindly growth by excess heat or crowding. A rapidly growing succulent stocky plant will give the best and earliest returns.

In recent years, research has shown that tomato seedlings can be induced to produce a flower cluster lower on the plant if they were given a cool temperature treatment at the right stage. Germination should be at about 75°F., and when the cotyledons are fully expanded the plants are kept at 50 to 55°F. for two weeks. More flowers will appear on the first two clusters, and these clusters are closer to the ground.

Preparation for Planting

As with other crops the soil must be thoroughly worked to incorporate organic material from the previous crop and to loosen the soil. A soil sample (see Page 14) should be taken before or at the time of cultivation to determine what fertilizer should be added.

Several days before planting, the soil should be well watered. In this way, the soil will be moist but not muddy at planting time. Good condition of the soil and a proper moisture content allow the plant roots to start spreading immediately.

Planting

It has been found that the optimum space per plant is about 3½ to 4 square feet. Distance between rows and between plants in the row is not particularly critical, ideally spacing should be as nearly as possible "on the square". In practice it is found that rows must be at least 30 inches apart in order for a person to work comfortably between them. Some growers place two rows closer together (about 2 feet), then the next two at least 3 feet apart. This spacing is to facilitate working among the plants. All work is done from the wider space. It is important to use all the space in the greenhouse as efficiently as possible, but crowding excessively tends to result in a lot of small fruit and favours leaf diseases. Overly wide spacing does not use all the greenhouse area to its fullest extent.

The actual planting operation can be an important stage in the growth of the crop. A deep wide hole should be prepared for each plant so the whole ball of earth from the pot can be put into the hole without breakage. The hole should be deep enough that the plant will be about an inch or more deeper in the soil than previously. Any setback or shock at this stage will cause a delay in fruit ripening. This is particularly important in the spring crop. Pulling plants out of a flat or shaking dirt off the roots to simplify or speed planting is never justified.

Temperature

For the growing crop, a temperature range of 70 to 75°F. during the day and 60 to 65°F. at night is considered optimum. During very bright weather, temperatures somewhat higher than 75°F. will not harm the plants but above 85°F. there will be a definite injury to blossoms. The temperature should not drop more than one or two degrees below 60°F. at any time when fruit buds are developing. If a developing bud is cooled, misshapen flowers and fruit occur, or the fruit may not set at all.

Although plants will survive a much greater temperature-range than 60 to 75°F., maximum yield will be obtained only if this range is carefully observed.

Light Conditions and Their Effect

During the fall, from mid-October on, flowers of most varieties grow with a slightly different shape, and natural pollination becomes more difficult. This appears to be a result of the low-light conditions and is aggravated by high soil-fertility. It is desirable to ensure pollination by periodically tapping the stakes or strings on which the plants are supported to shake the pollen from the anthers to the stigma. For pollination purposes, electric vibrators of several kinds are available. They are usually powered by a dry-cell battery. The operator walks down the rows and touches the vibrator to any flower cluster which is in bloom. This treatment is usually unnecessary in the first part of the fall crop and in the latter part of the spring crop.

Fertilizer for the Tomato Crop

Formerly a great deal of manure was used, and chemical fertilizers were used sparingly or not at all. Because there is now a limited and decreasing supply of manure, chemical fertilizers are most used.

Nitrogen is usually supplied in very limited quantities before planting, better results being obtained by later application to the growing crop. An experienced grower can tell when he needs nitrogen before there is any serious effect on the plant. The less experienced grower is well advised to send soil samples to a testing laboratory every two to four weeks (for nitrogen readings). Even frequent soil tests will not keep up with the rapid change in levels of nitrogen. A deficiency of nitrogen shows up as a general paleness of the foliage, particularly near the top of the plant. It is necessary to acquaint yourself with the symptoms of nitrogen deficiency so you can supply the plants' needs quickly. For the fall crop, only one or two applications of 3 to 4 pounds of ammonium nitrate per 1000 square feet of area are needed. The spring crop may require two or three of these applications. On very sandy soil, more frequent applications are necessary due to leaching.

Both phosphorus and potash may be applied before working the soil. About 20 to 30 pounds of each of superphosphate and muriate or sulphate of potash should be added per 1000 square feet. If a mixed fertilizer is used, approximately 30 pounds of 0-20-20, or its equivalent, per 1000 square feet would be an average application.

Minor elements are seldom a problem in greenhouse culture, particularly if some manure is used or if organic mulching-materials are worked into the soil periodically.

A few soils are naturally acid (sour) or slowly become more acid with use. The only way to know if your soil is acid and requires liming is by a soil test. When your report of a soil test is returned, pH (acidity level) is reported. If your pH is between 5.6 and 6.8 you are in the optimum range; if readings are below 5.6 it is well to add some lime before the next crop. Your soil-test laboratory can advise you on kind and quantity of lime. Adding lime once a crop is in the ground is not likely to help.

Mulching

At the time the tomato plants are about two feet high it is advisable to mulch the soil. Straw is the most common mulching material. The mulch will

reduce evaporation of water from the soil and compaction of the soil surface. If mulch is present there will be very little dirt splashed onto the plants during watering.

Watering

The object of watering is to maintain a fully adequate supply of water to the plant roots without at any time having the soil so wet that air does not get to the roots. It is not good to wait until the plants start to wilt before watering. A good practice is to use a narrow shovel to dig into the soil to a depth of 12 inches to judge how much water is left. The "feel" of the soil is some indication of water need but the use of a moisture meter is advisable.

Watering regularly on a given day of the week is ridiculous. The plant's water requirement changes from day to day, and certainly with different seasons of the year. Young plants put in the greenhouse in January or February need to be watered only once in ten days or two weeks, and then only enough to soak 6 to 8 inches of soil. The same plants in June may need five to ten times as much water.

Varieties

Two crops of greenhouse tomatoes are grown in Ontario. Since light and temperature relations are different in the spring and fall seasons, different varieties are usually grown.

In the fall, leaf mold caused by *Cladosporium fulvum* is a major disease and resistant varieties should be grown. Vulcan has usually proved the most profitable in spite of its susceptibility to two races of mold. If leaf mold has been severe, then a resistant variety like Vinequeen (V546) should be used. Formerly Improved Bay State or Vagabond were used to obtain resistance to leaf mold but Vinequeen is considered superior in resistance as well as other characteristics.

In the spring, leaf mold can usually be controlled by cultural methods. Susceptible varieties may therefore be used. However, varieties must be able to set well under the low-light conditions of February and March. Tuckqueen is generally the most satisfactory but V-121, Potentate, Trellis #22, Northern Hybrid and Michigan-Ohio Hybrid are preferred by some growers. If leaf mold has been a problem in this crop, Vinequeen is recommended.

Most Ontario markets require red tomatoes which go four or five to the pound. There is a trend, however, toward a slightly larger fruit size. Demand for large pink varieties of the Globe type, though still quite small, is increasing. Small-fruited varieties such as Ailsa Craig, Best of All, and Grand Rapids should only be grown for special markets.

Diseases

Leaf Mold. This is the most important disease of the greenhouse tomato crop. Usually the first sign of the disease is a small grey spot on the upper side of the leaf. This becomes an olive brown and gives off many spores spreading the infection. On the upper surface of the leaf there is a slight discoloration and later a definite pale area somewhat smaller than the spot on the lower side.

A basic control measure is sanitation around and in the house. The old-crop foliage should be completely removed and not left anywhere near the new crop.

The spores of the leaf-mold organism can germinate and cause new infection only under fairly humid conditions, so careful ventilation and temperature control to prevent high humidity at all times is helpful.

Several varieties that are highly resistant to leaf mold are available and should be used. However, even with these varieties, it is advisable to use sanitation measures and to ventilate properly.

Spraying with a fungicide at weekly intervals throughout the whole crop starting at germination has proven helpful. The material maneb (Dithane M-22 or Manzate) has been reasonably effective. Three pounds of actual material per 100 gallons of water is recommended. Do not depend on the chemical alone. Proper sanitation and ventilation can be supplemented by chemical sprays.

Wilt. The two organisms causing wilt (*Fusarium* and *Verticillium*) are very different but their effect on the plant is similar. In both cases the affected plants at first show temporary wilting on hot days then eventually wilt all the time and the leaves become yellow. If the plant is cut just above the soil surface, a darkened ring is visible inside the outer green layer of cells.

Both diseases live in the soil and enter the plant through the roots. No spray or cultural treatment will control these diseases. The only way in which they can be controlled is by soil sterilization (see Page 11).

Early Blight and Leaf Spot. Early Blight and Leaf Spot (*Alternaria* and *Septoria*) cause discolored or dead spots on the leaves. The *Alternaria* has small black dots within the affected area. In the *Septoria* blight, each spot has darker rings on the brown background.

Both of these organisms attack the oldest leaves first and often cause severe defoliation of the lower part of the plant. *Alternaria* frequently attacks the sepals and infection spreads to the stem end of the fruit causing a rot near the stem attachment. Growers often remove some of the lower leaves, but in this way they reduce the plant's efficiency even more rapidly than the disease does. Removing the lower leaves may help somewhat in improving air movement and in this way reduce infection, but only badly affected leaves, not healthy ones, should be removed.

As is true with leaf mold, excessive moisture in the air or on the foliage favours infection. When watering, do not wet the foliage if it can be helped. Careful ventilation will also reduce the severity of the disease.

No varieties that are commercially valuable have any degree of resistance to these diseases.

Spraying the foliage with maneb (see Page 33), will help considerably in reducing these diseases.

Grey Mold. The organism (*Botrytis*) causing this rot normally lives on dead or dying tissue but is mildly parasitic. Where leaves have been pulled from the plant the open wound provides a site for infection. Also, a dying leaf hanging on the plant may be attacked. Under high humidity conditions a watery rot develops and a fluffy grey growth forms over the affected area. The disease may develop along the stem for several inches and frequently a plant is girdled and dies above the point of infection.

Moderate or low humidity conditions maintained by thorough ventilation and heating will prevent spread of the disease. Affected areas of a plant may be scraped and covered with a paste made of a fungicide (like Ferbam), the plants can be sprayed with Ferbam.

Virus. There are several types of virus that attack tomato. Some are much more severe in their effect than others, but all cause some distortion of the leaves and stunting of growth. In all cases yield will be reduced.

Virus diseases act entirely inside the plant so chemical sprays or ventilation control will be of no benefit once infection occurs. The disease is spread by sucking insects or on the hands or tools of the people working in the crop. Juice containing the virus must be mechanically transmitted from the diseased to the healthy plant.

Control of all insects, but particularly mites and aphids, will reduce initial infection or subsequent spread. Since the virus must come from an infected living plant, sanitation in and around the greenhouse is very helpful. Many plants, including some of the common ornamentals, carry the virus, and insects moving from them to the tomatoes can transfer the disease.

Spread of virus by humans may occur during pruning, tying, digging, or picking. Even moving between the plants and touching the leaves with your hands or clothes can spread virus. Frequently, infection occurs when the seedlings themselves are being handled. One of the common strains of mosaic is also common on tobacco. Someone using tobacco and then touching the small plants can cause a high per cent infection even before the plants are planted in the house. If you or your help smoke or chew tobacco, it is advisable to wash the hands very thoroughly with soap and clean hot water before any operation in which you must touch the tomato plants.

Insects

Greenhouse Whitefly. This is the most common pest in the greenhouse tomato crop. The insect is easily identified by its snowy white colour, and its triangular shape when at rest on a leaf. When the leaves are disturbed, the insects take to the air, fluttering about like tiny snowflakes. The insect secretes a sticky substance on the leaves and fruit. A black fungus grows in this deposit making it necessary to clean the fruit before sale. The feeding of the insects can cause serious damage to the plants and to the quality of fruit.

Control of whitefly can be obtained with most insecticides in the form of aerosols, smoke generators or sprays. Dithio or TEPP aerosols at 5-day intervals, for 3 to 4 weeks will give good control. If a spray is preferred 25% malathion at 2 pounds per 100 gallons, or 50% perthane at 2 pounds per 100 gallons will be effective. Nicotine smoke is still widely used and does control whitefly, but it is less effective than the other materials (see Page 33 for precautions).

Two-spotted Spider Mite (Red Spider). This pest is not found as often as whitefly but it does a great deal of damage when it becomes established. The tiny mite varies in colour from yellow to red and carries a dark spot on each side of its body. An injured leaf has a very characteristic bronzed appearance. Usually the bronzing starts near the base of a leaflet and progresses outwards. The bronzed appearance is the result of dead brown cells in the leaf. The mite sucks the contents out of a cell, leaving a dead shell. When an area of cells has been killed, they appear as bronzed spots.

Between crops, the house should be completely cleared of all plants or plant refuse. The empty house may be treated in several ways. Sulphur (4 pounds per 1000 cu. ft.) can be burned in the closed, dry, warm empty house. Spray oil may also be used to treat framework and walls. A heavy parathion fumigation will kill off mites and other insects and reduce the chance of infection of new crop, or the whole house may be sprayed with aramite 1½ pounds per 100 gallons.

Infestations on the growing crop may be controlled, by malathion sprays, or by Parathion or TEPP aerosols. Both are highly effective but should not be used on young plants till some fruit is formed.

Aphids. Several types of aphids, ranging in colour from pink to dark green, feed on tomatoes. They suck the juices out of the plant and cause the leaves to curl. With serious infestations, the leaves are badly distorted and die. A sticky deposit (honeydew) on the fruit necessitates careful cleaning.

A single application of TEPP, malathion, parathion, or Dithio will usually control aphids. (See Page 34). Nicotine smoke generators will give some control.

There are several other insects that occasionally attack tomatoes. For control see the Protection Calendar for Vegetables Under Glass prepared by the Ontario Department of Agriculture and Canada Department of Agriculture.

PEST CONTROL CHEMICALS

Recommendations for pest control are mostly with new organic fungicides or insecticides. Some chemicals not mentioned in this bulletin have been successfully used for many years by some greenhouse operators. It is felt that the materials mentioned here are the most effective or the easiest to use but certainly not the only ones for control of any particular pest. For more detailed information on pest control see Protection Calendar for Vegetables Under Glass, available from Ontario Agricultural College, or from offices of the Ontario Department of Agriculture.

Organic Fungicides

These materials have largely replaced sulphur and copper for greenhouse disease control.

Ferbam (Ferbam, Fungay, Karbam Black and other brand names of Ferbam). This material is a general fungicide for a wide range of diseases.

Maneb (Dithane M-22, Manzate). This is a fairly general fungicide particularly effective for control of early blight, leaf spot, and leaf mold of tomato.

Thiram (Arasan, Thiram). Thiram is particularly effective as seed treatment or where soil must be treated as for late damping-off.

Nabam (*Zineb and Ziram*). These are general fungicides sometimes substituted for the above.

Karathane (Karathane WD, Iscothan) is very effective against powdery mildew. Leaf injury may occur if Karathane is used at temperature approaching 90°F. and also when it is combined or alternated with other spray materials, particularly sulphur.

Fixed Copper (Basi-cop, C.O.C.S., Cupro-K, Spraycop 530, Tri-cop, Cupro-cide, Trox).

Fixed copper is particularly effective for tomato leaf diseases. It can cause some damage to open flowers and should be used only to combat serious infections.

Insecticide Aerosols and Smokes

Applying insecticides as aerosols or smokes saves a great deal of time and labour. Large areas can be treated in a very short time. The insecticides are suspended in the air and move to all parts of the house giving more complete coverage than is possible with a spray.

Since the insecticide is suspended in the air it is necessary to wear a full-face gas mask with the proper cartridge to prevent poisoning of the operator.

Caution

All insecticides recommended are poisonous to humans to some extent. In particular, the organic phosphate materials (Parathion, Malathion, TEPP and Dithio) are very highly toxic and should be used with extreme care.

Residue tolerances on food crops have been established for all pest control chemicals. To meet these tolerances, follow directions on the manufacturer's label exactly. This refers particularly to the time interval which must be provided between use of a given material and harvest of the crop. Some of these time intervals are given:

TABLE I
TIME INTERVAL WHICH MUST BE ALLOWED BETWEEN INSECTICIDE APPLICATION
AND HARVEST

Insecticide	Cucumber	Lettuce	Radish	Tomatoes
	Days	Days	Days	Days
Parathion	15	21	15	10
Malathion	1	10	3	3
TEPP	3	3	3	3
Dithio	15	21	15	15
Aramite	15	seedlings only	not established	15
DDT	5	seedlings only	no limit	5

Bees

When using the aerosols or smokes for insect control, bees must be removed. Usually treatment of the greenhouse is overnight, so the hive may be closed and removed, then returned after the greenhouse has been aired in the morning.

ACKNOWLEDGMENTS

Much of the information contained in this bulletin was obtained from those men conducting research or carrying on extension work in the field of greenhouse vegetable production. Some of these men kindly consented to read the manuscript and to make suggestions for improvements. Special thanks should go to Mr. D. C. Hamilton, Ontario Agricultural College, Guelph, Ontario, Mr. Robert Walsh, Science Service, Harrow, Ontario, and Drs. E. A. Kerr and W. H. Upshall of the Horticultural Experiment Station, Vineland Station, Ontario.

A number of bulletins from other institutions were used to obtain information presented here.

CARONAF6
B527

ONTARIO LAYING FLOCK MANAGEMENT



Poultry Range, Plant and Graham Hall, Ontario Agricultural College.

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

Dr. C. D. Graham
Deputy Minister

Hon. W. A. Goodfellow
Minister

ONTARIO LAYING FLOCK MANAGEMENT

BY J. P. WALKER, ASSISTANT PROFESSOR OF POULTRY HUSBANDRY

WITH FOREWORD BY J. R. CAVERS, PROFESSOR AND HEAD,

DEPARTMENT OF POULTRY HUSBANDRY,

ONTARIO AGRICULTURAL COLLEGE,

GUELPH, CANADA

TABLE OF CONTENTS

FOREWORD 5

BROODING AND REARING 7

 Comparison of Brooder Stoves 9

 Management 12

 General Requirements for Brooding 14

 Litter 14

 Ventilation and Humidity 15

 Crowding 15

 Chilling and Overheating 15

 Cannibalism 15

 Sanitation 19

RANGE REARING 20

 Permanent Pastures 20

 Permanent Pasture Mixtures 21

 Annual Pastures 22

 Range Equipment 23

 Range Shelter 24

 Range Nests 26

 Feeding 26

 Predators 27

 External Parasites 28

CONFINEMENT REARING 28

STARTED PULLETS 31

HOUSING PULLETS 31

 Methods of Moving and Management 31

FEEDING LAYERS 33

 All Mash 33

 Grain and Mash 33

 New Grain 34

 Oyster Shell 34

 Grit 34

 Water 34

LAYING PEN EQUIPMENT 36

 Feed Troughs 36

 Nest and Nest Litters 36

 Artificial Lighting 41

EXTERNAL PARASITES	42
Red Mite	42
Northern Fowl Mite	42
Lice	43
CANNIBALISM	43
VENTILATION AND USE OF FANS	45
LITTER AND LITTER MANAGEMENT FOR LAYERS	50
MANAGEMENT OF THE BREEDER FLOCK	53
Selection	53
Management	53
Feeding	53
Growing Cockerels	54
Government Policies	54
WIRE AND SLATTED FLOORS	55
LAYING-CAGE OPERATION	57
Advantages	57
Disadvantages	57
Houses	57
Cages	57
Lights	59
Program	59
Culling	59
Feeding	59
Water	61
Fly Control	61
External Parasites	61
Dubbing	62
Beak Clipping	62
Group or Colony Laying Cages	62
Advantages over the Single Cage	62
Disadvantages	62
MANAGEMENT FOR MARKETING TOP QUALITY EGGS	63

FOREWORD

Egg production is the major poultry enterprise in Ontario and elsewhere in Canada. Estimated value of Ontario poultry products in 1956 is given by the Dominion Bureau of Statistics as follows:

eggs for market	\$56,777,000
eggs for home use	5,686,000
eggs for hatching	3,257,000
chickens and fowl	56,933,000
turkeys	11,798,000
ducks and geese	1,618,000
total	\$136,069,000

Included under the item "chickens and fowl" are commercial broilers worth approximately 13 million dollars at farm (author's estimate). The remainder under this item are mainly chickens and fowl which could be regarded as by-products of egg production. Thus, despite great interest in broiler and turkey production in recent years, egg production and its related enterprises still represent around 80 per cent of the value of Ontario poultry products. The same holds true for Canada as a whole.

Ontario, with one-third of Canada's human population, produced 38 per cent of Canada's eggs in 1956. Production is most concentrated in southwestern Ontario—from Oshawa and Toronto through to Windsor, and from Lake Erie north to Georgian Bay; this tiny spot on the map of Canada supplies 30 per cent of her eggs. Within this area, the better grain-growing sections produce a surplus of eggs which go into inter-provincial trade, breaking and storage, and export. Elsewhere in Ontario, egg production is about in accordance with local market needs.

Poultry keeping in Ontario is no longer a universal farm enterprise. According to the 1956 census estimate, only 62 per cent of Ontario farms have poultry of any kind. Flocks are becoming fewer and larger, and the industry more intensified. Nevertheless, farm flocks of 200 to 500 hens are still the backbone of Ontario egg production. These and somewhat larger flocks are operated on a semi-commercial basis and form one of perhaps three main enterprises on a given farm—a development endorsed by agricultural economists. There are a number of large commercial flocks in each county, but the production from these forms only a small part of the total.

Climate has little effect on the performance of Ontario hens, but it does affect the chicken-hatching season. Unlike broiler chicks, which are produced in about the same volume each week of the year, two-thirds of Ontario replacement chicks are hatched in four months—February to May inclusive. Elsewhere in Canada, the chick season is even more restricted, over 70 per cent of non-broiler chicks being hatched in three months—March, April, and May. Since the middle 1920's, the hatching season has become progressively earlier, but few farmers have accommodation for rearing replacement stock indoors beyond the brooding stage; consequently, not many egg producers want chicks before February or March.

The seasonal nature of Canada's replacement chick hatching is reflected in a heavy run of market eggs commencing about mid-November and reaching a peak early in January. Hatchery settings and the culling of flocks due to a normally weak winter egg market help to reduce the winter flow of eggs to market. Spring weather usually induces a second peak towards the end of May, after which production from year-old flocks drops rapidly with the onset of summer weather.

Grade A Large eggs are normally in short supply throughout the summer and early fall. During the same period, production from pullets hatched from February to May keeps the market burdened with small eggs.

The hatching of replacement chicks in October, November, and December has been a significant factor in Canada's egg supply since 1953. Fall hatching is well established in Nova Scotia, and the practice is increasing in Quebec, Ontario, and British Columbia. It involves confinement rearing. The purpose of fall hatching is to have pullets matured and past the stage of laying small eggs by June, which now marks the start of a 4- to 5-month period when the differential in price between sizes of fresh eggs is an important consideration.

Fall hatching represents the final step in providing the Canadian market with a steady supply of fresh eggs the year around. Already the need for storage of eggs in shell has been eliminated. Nevertheless, surplus egg production continues to be a problem during the winter and spring; this situation will continue until the proportion of March to May replacement chicks is reduced.

Ontario grows sixty per cent of Canada's broilers, and these are having a considerable impact on the egg industry. Breeding for a specific purpose, year-round hatching and rearing, mechanical ventilation to reduce

floor space requirements, high energy diets and emphasis on feed efficiency, volume production to offset low margins of profit—all have been stimulated by the broiler industry. Broilers have replaced much of the heavy roaster trade and dealt a serious blow to the fowl market.

There is now a clear distinction between broiler and non-broiler stocks, the main reason being that selection for rapid and economical growth in broilers appears to lead automatically to large body size and large appetites in adult stock. Commercial egg producers are turning to strictly egg-type strains and crosses, aiming for a feed conversion of around four pounds per dozen eggs and counting as salvage the returns from fowl; the cockerel chicks are destroyed at the hatchery. Ontario farm flock owners traditionally have favoured dual-purpose stock, and that is still the case, but with more emphasis now on egg strains.

Prospects are for an increasingly competitive poultry industry with the market continually under the pressure of full production. Larger flocks will be required in order to maintain income in the face of narrower margins of profit per dozen eggs or per pound of poultry. Integrated selling methods may be developed as a means of gaining full advantage from the production of high quality eggs under controlled conditions of management. As production levels out, egg producers are faced with the necessity of making their profits week by week without the likelihood of high price seasons for eggs or strong markets for fowl. Poultry keeping is becoming more and more a business proposition.

BROODING AND REARING

The ability to grow good pullets year after year is the best test of a successful poultryman. The improvements in feeds and brooding equipment make the growing of pullets easier today than ever before. Given strong healthy chicks from blood-tested strains bred-to-lay, and good equipment, the limiting factor is the man in charge.

The colony house system of brooding is still the practical way to raise small flocks. For winter brooding in colony houses, a large coal or wood stove will provide sufficient heat to raise good chicks. The new type of oil stove will also provide sufficient heat for winter, but the fuel costs will probably be higher.



Fig. 1 and 2—Quonset-type colony brooder house, 12' x 16'.

COMPARISON OF BROODER STOVES

TYPE OF BROODER WOOD

ADVANTAGES

Provides enough heat to warm the colony house and keep the litter dry.
Cheap fuel in areas where used.

DISADVANTAGES

High labour requirement.
Pipes must be cleaned regularly.
Some danger of fire.
Hard to control temperature in warm weather.

COAL

Provides enough heat for winter brooding and keeps the litter dry.

High labour requirement.
May be a fire hazard.
Hard to maintain suitable temperature in warm weather.
Fuel costs fairly high.

OIL (Stackless)

No stove pipes required.
Temperature easily adjusted.
Provides desired temperature in both cold and warm weather.
Low labour costs.

May occasionally require cleaning.
Must be level to operate.
Fuel tank should be outside brooder house, otherwise fumes will be objectionable.

GAS (Propane)

Low labour requirements.
Automatic temperature controls.
Does not depend on electricity.

Cost of installation too high for small scale use.
In cold weather there may not be enough heat to keep the litter dry in the pen.
Fuel is expensive when used in small quantities.

GAS (Natural)

Same as for Propane.
Fuel cheap in areas where used.

Extra ventilation required to remove combustion gases.
Extra ventilation necessary to remove gases.

ELECTRIC BROODER

Automatic temperature controls.
Low labour requirements.
Cheap operational costs.
Low fire hazard.

Depends on electric power.
Requires auxiliary heat in cold weather.
Litter sometimes becomes damp under hover (poor ventilation).

INFRARED

Suitable for a few chicks.
Everything in pen may be checked at a glance.
Good ventilation around the chicks.
Low fire hazard.

Depends on electric power.
Power costs high.
Requires auxiliary heat for winter brooding.

CENTRAL HEATING

Low operating costs.
Low fire hazard.
Temperature controlled easily.

Depends on electrically operated controls.
Installation costs high.



Fig. 3—Stackless oil brooder stove set up ready for chicks.



Fig. 4—A slag block permanent brooder house using gas brooders.
Note the bulk tank, flood lights, and incinerator.



Fig. 5—A large pen in a permanent brooder house using gas brooders and a duct system to provide preheated fresh air.

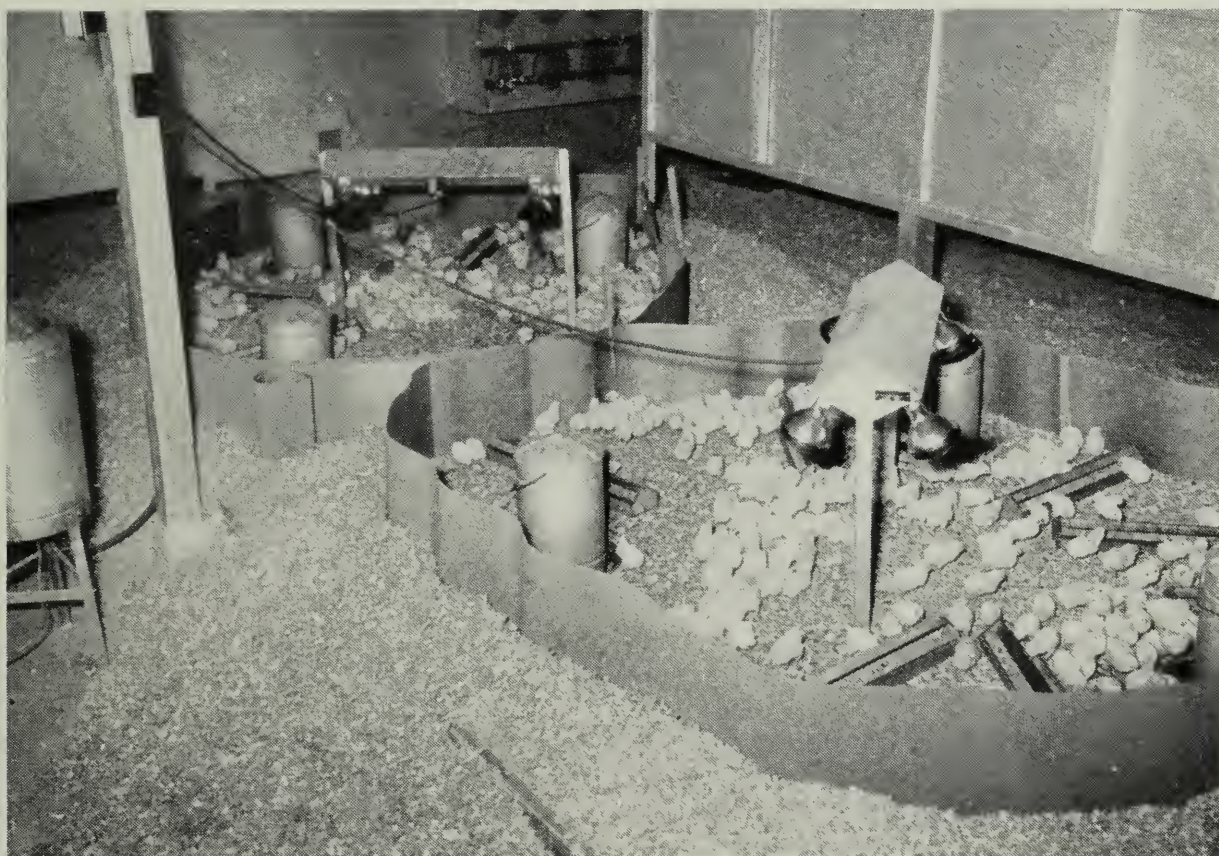


Fig. 6—A section of a pen using infrared bulbs and stackless oil stove as auxiliary heat.



Fig. 7—A section of a pen in a permanent brooder house showing a unit space heater. Note the exhaust fan in the wall.

The permanent brooder house is more economical when the flock is larger (2,000 chicks or more). In most cases it can be used the year round for brooding and rearing pullets and housing layers; thus the overhead costs are low. Less labour is required because everything is under one roof, and labour-saving devices such as automatic waterers, mechanical feeders, and controlled heating systems may be used.

There are many types of heating systems used in the permanent brooder houses, and they all have advantages and disadvantages. One disadvantage with almost all central heating systems is that they are controlled electrically. When a new heating system is being installed, some precautionary measure should be taken against power failure. For example, in a hot water system, provision should be made for gravity flow when the pumps are off. With electric brooders or infrared brooders, some auxiliary heat such as hot air or hot water should be used.

Management

The first few days in the brooder are important in the life of the chickens as conditions then or habits acquired may have a serious effect on their future growth. The brooder pens should be ready for the chicks before they arrive. The temperature 2 inches above the litter at the outer edge of the hover should be 95° to 98°F. The litter should be evenly

distributed over the floor and approximately 2 to 3 inches deep to serve as a floor insulation.

It is usually wise to have a cardboard chick guard encircle the brooding area for the first few days. This keeps floor drafts from the chicks and at the same time keeps them close to the source of heat so that they cannot wander too far away and become chilled or pile up in the corners.

One 4-foot chick trough filled with feed should be provided for each 100 chicks. The first day is the only time it pays to fill a trough to the top, which helps the chicks learn to feed a little sooner. From then on feed troughs should not be more than about half filled, or too much feed will be wasted.

It is a common, but harmful, practice to put feed on newspaper and egg flats. Tests have shown that the chicks do not learn to eat any faster or grow faster than when feed troughs alone are used. When these papers or egg trays are removed, the chicks have to learn all over again where to find feed and, as a result, often start eating litter and thus may more readily pick up disease. This use of paper not only wastes a lot of feed but is unsanitary and requires much more labour. If there is plenty of light over feed troughs and waterers and the chicks are strong and healthy, they will start to eat without any trouble.

Make sure that feed is available for the chicks when they are put in the pen. Chick starters should be fed for the first eight weeks, although the feeding of chick grain for the first day may be helpful in preventing pasting. Starting at seven weeks of age, a small quantity of good quality oats may be fed along with the chick starter. From eight weeks of age until the pullets are ready to lay, a chick growing mash should be fed along with the whole grain. The mash should be fed free choice, the grain according to mash consumption. By twelve weeks of age, they should get approximately 75 parts of mash to 25 parts grain; by 14 weeks of age, 60 parts of mash to 40 parts of grain; by 16 weeks of age, 50 parts of mash to 50 parts of grain. All feed should be measured by weight, never by bulk. The above feeding recommendations are meant only as a general guide for confinement rearing. It is wise to follow the feeding recommendations of the company whose feed you are using.

Insoluble grit should be fed from the time grain-feeding begins.

A continuous supply of clean, fresh water is important if chicks are to thrive. The first few days it is advisable to take the chill off the water and have a water fountain near each feed trough.

The feed troughs and waterers should be arranged around the source of heat so that the chicks can move to, or away from, the heat without piling up against troughs and smothering.

GENERAL REQUIREMENTS FOR BROODING

Age of Chicks	Feeding Space Per Chick	Watering Space Per 100 Chicks	Floor Space Per Chick	Temperature Under Brooder
1 day - 2 wks.	1"	2 1-gal. fountains	1/2 sq. ft.	95°F. - 98°F.
3 wks. - 7 wks.	2"	2 3-gal. fountains	3/4 sq. ft.	drop temperature about 5°F. per week
7 wks. - 12 wks.	3"	2 5-gal. fountains	1 sq. ft.	
13 wks. - 20 wks.	4" per bird	60" per 100 birds	2 to 3 sq. ft. per bird when confined	

These recommendations may be varied depending on circumstances. It does not pay, however, to crowd chicks. Better growth for replacement stock will result if not more than 350 chicks are started under one brooding unit. Larger feeders and waterers should be used as the chicks grow. Leaving small feeders in the pen too long results in litter being scratched into the troughs, and the birds may eat too much litter, with trouble resulting. Placing welded wire under the feeders and waterers will help to prevent this, but care must be taken to move the feeders regularly or the litter will become packed.

Litter

Shavings, chaff, cut straw, sawdust, corncobs (put through a hammer mill), rice hulls, peat moss, peanut hulls, expanded mica, and sand make suitable brooder pen litter. Availability and cost should be the deciding factors.

The depth of litter used varies with brooding systems and the physical makeup of the litter. Litter should not be so coarse, deep, and loose that it hinders the chicks moving around the pen. The depth of litter should be sufficient to keep the chicks off cold floors.

Very seldom is it necessary to clean out the brooder pen until the chicks have been moved; instead, new litter is added periodically. The feed troughs should be moved regularly to distribute the droppings uniformly and thus reduce damp and crusty litter. The litter should be stirred when necessary as a further deterrent to packing.

The problem of chicks eating litter is usually the result of poor management practices rather than the type of litter. Litter-eating should not be a problem if sufficient feeders with feed available for the chicks are located in well-lighted areas around the hover. Spilling feed in the litter or allowing feed troughs to remain empty may start chicks eating litter.

Ventilation and Humidity

The first two weeks the humidity should be reasonably high (about 65 to 70 per cent relative humidity) for more rapid feathering. To maintain this humidity it may be necessary to spray some water on the walls periodically. From two weeks on the humidity should be kept down as much as possible. This is done by good ventilation and heat from the brooder.

From the first day to maturity, chicks should be given as much fresh air as possible without chilling them or creating a draft. This is where many poultrymen fall down. The birds themselves require plenty of oxygen. The carbon dioxide and most of the moisture they give off can be removed only by ventilation. In addition to this requirement, many types of brooder stoves require oxygen. It is much better to burn a little extra fuel to maintain pen temperature but at the same time have plenty of ventilation. Good ventilation is as important at night as during the day.

Management Problems

Crowding is a common problem. It is often the result of drafts, chilling, or over-heating, and occurs when the chicks follow the sun's rays in the late afternoon. Therefore, it is always wise to check the chicks just at dark to make sure everything is as it should be. The poultryman who does this at least the first few nights gets the birds started on regular habits which may save him losses later on. The chicks spread out evenly in a circle just at the outer edge of the brooder. The chick guard should help during the first few days, and after it is removed the corners should be blocked off. Should crowding become a problem, it is advisable to leave a light on over the brooder. This is particularly true if the brooder house is located where car lights flashing through the windows frighten the birds.

Chilling and Overheating probably occur more often in colony brooder houses than in permanent brooder houses and are the result of the operator's not checking often enough to make sure everything is in order. Chicks can withstand chilling for longer periods than overheating, but either may result in digestive troubles and, if severe enough, affect growth. When chicks are overheated, they flatten out and pile around the edge of the pen; when chilled, they crowd the source of heat and are noisy.

Cannibalism is a vice which is causing more trouble each year and is probably the result of a combination of feeding, breeding, and management. The use of diets low in fibre content and the use of feed in crumble or pellet form seem to have increased feather picking and cannibalism because the chicks require less time to satisfy their appetite and thus have nothing to do for longer periods.



Fig. 8—An electric cauterizer and stand.

Heredity is probably another contributing cause of cannibalism. The temperament of the better laying strains is different from most meat or dual-purpose strains. This may lead to feather picking, even when good management practices are followed.

From the management standpoint, overheating is probably the main cause of cannibalism, which, of course, is tied in with ventilation and humidity. Lack of sufficient floor space, feeder space, or water space, and too bright a pen may be factors causing cannibalism.

In many cases, cannibalism becomes so bad that it is necessary to clip the beaks of the chicks. This may be done with an electric cauterizing

knife, but, if the chicks are under three weeks of age, the water-cooled attachment should be used. The water-cooled attachment allows a definite amount of both the upper beak and the tip of the lower beak to be removed. The water-cooling reduces the danger of mortality from shock.

For birds from about four weeks of age on, the regular electric knife attachment is used, and the upper beak should be removed to within approximately $\frac{1}{8}$ of an inch from the nostril. The tip of the lower beak should be seared to slow down its growth.

Removing part of the beak is not so simple as most people assume. In some cases, considerable mortality has resulted, particularly in young



Fig. 8-a—An electric cauterizer with water-cooling attachment.

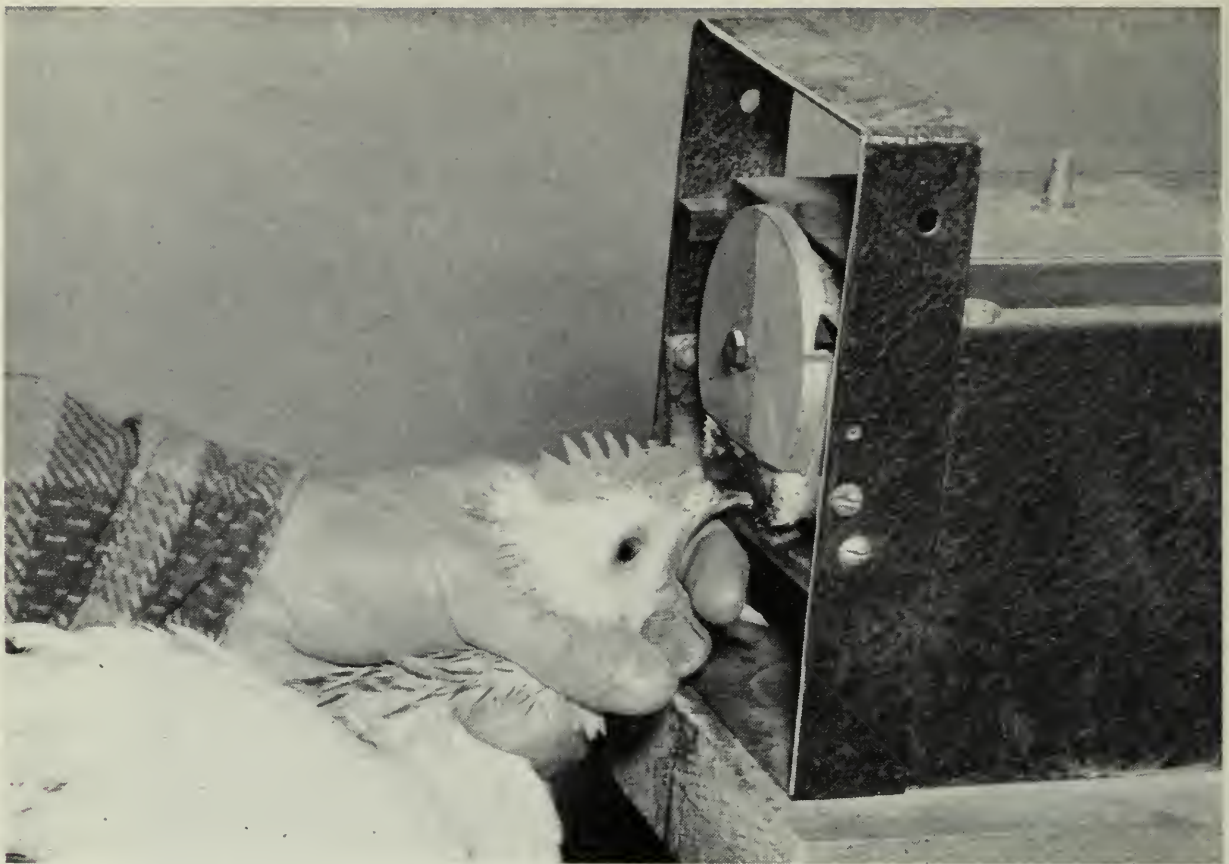


Fig. 9—A closeup view showing the correct position for holding the bird.



Fig. 9-a—The correct position for holding the chick when using the water-cooling attachment.

birds. For this reason, speed is of minor importance; the first essential is to make sure the cut is properly cauterized. A good insurance measure is to add some vitamin K to the drinking water for two or three days before beak clipping. Another precaution is the use of high level antibiotics in the feed a few days before and after beak clipping.



Fig. 9-b—The chick with a block-type cut. There is no sign of bleeding and no excess searing.

The attendant who notices the start of cannibalism may be able to stop it if he determines the cause and corrects this. He should then cover any picked areas on the birds with pine tar or other anti-pick ointment.

For late-hatched chicks, moving them to range will usually stop picking while they are outside.

Sanitation

At all times in any poultry plant, all possible sanitary measures should be practised. This is particularly true during the growing period. It is not necessary or desirable, however, to clean out the pens every week.

In addition to all houses and equipment being thoroughly cleaned before the chicks arrive, probably the most important factor is complete isolation from adult stock. When practical, different attendants should look after the chicks and old birds; if this is not possible, look after the chicks first.

From the standpoint of leukosis alone, it pays not only to buy chicks from stock that have low mortality from this disease but also to keep the chicks as completely isolated as possible during the entire growing period.

RANGE REARING

Many poultrymen believe they grow their best pullets on range. There is considerable experimental evidence to verify this. Pullets raised on good pasture and under good range management should go into the laying pens in top condition and be able to stand up to heavy production.

There is a tendency, however, to overrate the savings in feed costs when birds are raised on range unless a restricted feeding program is used. The main value in range rearing is probably the exercise the birds obtain and the supplemental value of a succulent green feed.

By the time pullet chicks are well feathered (eight to ten weeks), they should be moved to range, depending, of course, on the time of year. Not more than 400 pullets should be raised on one acre of good permanent pasture.

Permanent Pastures

A good poultry pasture should be planned as a regular part of a rotation program and have some shade either from trees, corn, and sunflowers, or by artificial sunshades such as aluminum sheets on stands about three feet high.

To be of any use to poultry, pasture should be immature; it is then tender and succulent and high in many vitamins and minerals. The same pasture at later stages is dry, stringy, and of no value. To maintain a constant supply of young grass, it is necessary to clip it regularly. A rotary-type mower with power attachment is excellent for this purpose because it mulches the grass and eliminates the danger of smothering.

Another advantage of keeping the pasture short is that it allows the sunshine to reach the ground, thus helping to reduce the problem of disease and internal parasites.

The permanent pasture should contain a blend of good quality legumes and grasses such as Ladino, White, Dutch, or Alsike clovers, and Kentucky Bluegrass, Canada Bluegrass, and Brome and Timothy grasses. Make sure the pasture mixture used is suitable to climatic and soil conditions.

PERMANENT PASTURE MIXTURES USED IN ONTARIO

Pennsylvania State College:

Kentucky bluegrass	6 lbs.
Perennial ryegrass	10 lbs.
Canada bluegrass	4 lbs.
Redtop	2 lbs.
Ladino clover	2 lbs.
White clover	1 lb.

University of Maryland:

Kentucky bluegrass	8 lbs.
Timothy	8 lbs.
Alsike clover	3 lbs.
Ladino clover	2 lbs.

Ohio State University:

Ladino clover	2½ lbs.
Domestic ryegrass	5 lbs.
(seed with clover in Spring)	
Kentucky bluegrass	6 lbs.
(seed in Fall)	
Timothy	4 lbs.
(2 lbs. in Fall)	

Cornell University:

Kentucky bluegrass	12 lbs.
Ladino clover	2 lbs.

Ontario Agricultural College:

Ladino clover	3 lbs.
Brome	12 lbs.

The above recommendations are pounds of seed per acre.



Fig. 10—View of a poultry range showing arrangement of shelters and colony houses. Note how short the permanent pasture is kept.

Annual Pastures

While not commonly used, annual pastures have a place on poultry farms with a limited acreage because the continual cultivation keeps the ground clean and allows more birds to be carried per acre.

For early spring pasture, fall rye is generally used. Oats are planted as soon as possible in the spring in narrow strips at about two-week intervals until mid-June, when they do not germinate well. Cereals planted for poultry pasture should be sown at about double the regular seeding rate.

For pasture in mid-summer and fall, a combination of corn and rape may be planted in June. The rape is very palatable and is eaten first, which gives the corn a chance to get started. The corn also provides some shade. Laying birds should not have access to rape since it gives the egg yolks a most objectionable olive-green colour.

To keep succulent growth coming along, cut annual pastures before they get ahead of the birds.

Range Equipment

Range equipment should be strong enough to withstand moving and still be light in weight. The feed troughs need not be fancy; probably an open trough about four feet long is as good as any. One four-foot trough for grower mash or crumbles and one for grain is sufficient for each 6- by 8-foot shelter. When feed troughs without covers are used on range, care must be taken in wet weather to make sure the birds clean up the mash each day, otherwise it may become mouldy.

In some cases where pellets are fed on range, no feed troughs are used, the pellets being broadcast by a fertilizer drill. This reduces labour and keeps the birds feeding over a wider portion of the range, with a resulting reduction in the number and size of bare spots.

For large poultry ranges located a long way from water, a feed and water wagon is probably the most economical method. This is one place on a farm where the horse is still better than a tractor; horses learn where to stop, and one man can drive the team and feed and water at the same time. With this system, hog troughs or old hot-water tanks cut in half make good water troughs. One of these troughs filled with water once a day will be enough for 75 birds.



Fig. 11—An efficient feed and water wagon. Note the type of feed trough and water trough used.

Poultry ranges located near water pressure systems can easily and economically be equipped with an automatic water system by using plastic water pipe. This system will ensure the birds a continuous supply of fresh water, whereas with storage tanks, etc., there is a continual problem of keeping the water troughs free from green slime (algae) and other growth.

Range Shelter

This is the most costly and important part of any poultry range. Many shapes and sizes of shelters are used, but probably the 6- by 8-foot shelter is the most popular. The 6- by 8-ft shelter shown here is light and easy to move and well enough braced to stand moving. The hinged wooden door over the wire back enables one to use this shelter in fairly rough weather as it is also protected on the side by the overhang of the roof. Slatted floors may be used for heavy breeds, but Leghorns and other light breeds prefer roosts. Since the skid of this shelter is part of the frame, it is a good idea to nail a 2- by 2-inch strip on the bottom which may be replaced when worn through; otherwise, the shelter frame would have to be torn apart to replace a skid. The hinged boards at the bottom, both front and back, enable the shelter to be moved without scattering the droppings around the range. Plywood, pressboard, or metal roofs may be used.



Fig. 12—Front view of 6- by 8-foot range shelter for 90 to 100 pullets, depending on breed.



Fig. 12-a—Rear view of figure 12.



Fig. 13—The A-type shelter, easy to move and construct.



Fig. 14—Range nest with burlap raised to show individual nest.

The A-type range shelter is another type which is light and cheap to construct and has the added advantage that it is hard for wind to catch and upset.

Range Nests

The pullets should be moved to the laying house before they come into production. However, there are exceptions. For example, either a new house may not be ready, or early-hatched pullets may be ready to lay but the laying house is too hot (no insulation); then range nests are necessary. There are many types of range nests used, but the main thing is to give the birds plenty of air and have a nest cheap to construct. Where colony houses are used on range, many birds will lay in them, but the eggs will be dirty. The box section of a community nest set on good sod against a shelter or colony house makes a good nest. The nest commonly used is the sectional nest with burlap bags hanging over the front to darken it.

Feeding

Most range grower mash is approximately 16 per cent protein and should be fed to birds from eight weeks of age to start of egg production.

While it is advisable to follow the feeding program recommended by the commercial company whose feed you are using, the following is a general guide for range birds on full feed:

12 weeks	50%	grain	50%	mash	} by weight
16 weeks	60%	grain	40%	mash	
20 weeks	70%	grain	30%	mash	

These proportions may be adjusted somewhat according to the rate at which the pullets are maturing and the quality of the pasture. Confinement grower should be fed in dry hot weather to offset the lack of pasture.

Good quality oats should be fed and may be left in a trough before the birds. Some wheat and/or corn may also be fed, the common practice being to give it as an evening feed of whole grain in a mixture of two parts oats and one part wheat and/or corn.

The results of an O.A.C. experiment shown in the following table give the approximate feed consumption during brooding and range rearing for White Leghorns, Rhode Island Reds, Columbian Rocks, Barred Rocks (broiler strain), and crosses of some of these breeds:

POUNDS OF FEED CONSUMED PER BIRD BASED ON 100 PULLETS
IN EACH GROUP

Age	W.L.	W.L. x R.I.R.	R.I.R.	R.I.R. x C.R.	C.R.	B.P.R. x C.R.	B.P.R.
0 - 10 wks.	7.1	7.0	7.2	8.4	7.4	8.1	7.7
11 - 20 wks.	12.4	13.6	15.3	15.4	16.4	16.5	15.6
0 - 20 wks.	19.5	20.6	22.5	23.8	23.8	24.6	23.3
Weight in Pounds							
at 20 wks.	3.4	3.7	3.9	4.3	4.5	4.9	4.8

Feeding Milk

Milk being an expensive product to buy, it has a limited use as a poultry feed. There are some farms, however, with a surplus of skim-milk or buttermilk which could be used as a source of protein for small flocks of growing birds. The skim-milk or buttermilk is fed after the brooding period when the birds are well feathered and on good pasture. A scratch mixture in separate troughs should be before the birds.

Milk should be fed in earthen or wooden containers and is usually given sour because it is almost impossible to keep a supply of sweet milk before the birds in hot weather.

Predators

Foxes—These cause more loss than any other predator. The best but most costly protection is a fox-proof fence round the range.

Shutting the flock in range shelters or colony houses each night is effective, but sometimes foxes will get the birds after they are let out in the early morning. The use of twenty parts crude furnace oil and one part spirits of turpentine when properly applied seems to keep the foxes from the poultry range. This mixture should be sprayed round the range in a strip about 3 feet wide, and this should be repeated about once a month. Near urban centres, foxes and dogs will sometimes cross this

strip, and then electric fencing may be used effectively. One strand of electric fence should be 8 inches above the ground and a second one 16 inches. The range beneath this may be sprayed with the crude furnace oil and turpentine mixture, but a mixture of 50 per cent carbolineum and 50 per cent kerosene will more effectively kill the vegetation and avoid the danger of grounding the electric fence. All-night lights will generally keep foxes away, but their use is limited by range location.

Owls and Hawks—Most of these birds are beneficial, but some will bother poultry. They are usually kept under control by shooting or by pole traps. Pole traps should be attached to a wire so the hawk or owl may reach the ground rather than hang suspended. Check with the local game warden regarding their use.

External Parasites (Mites)

The most common of the external parasites affecting birds on range is the common red mite. It usually appears when the weather starts to get warm (probably the latter part of June). Ordinarily they are black in colour, but after feeding they will be red. If a close check is made every week, they can be easily kept under control; however, once a heavy infestation develops, they are harder to check.

Control—The common red mite often winters in cracks and crevices in the walls and floor of the colony house. To make sure there are none present when the chicks arrive, it is wise to start the brooder stove several days ahead of time. With no litter on the floor, the presence of mites will be readily noticed and control measures may be taken. This is assuming that the colony house has been given a thorough cleaning the previous fall.

If roosts are dipped in a carbolineum solution once a year, it will usually keep mites under control. For outbreaks, there are many roost paints available under various trade names. Spraying the roosts and adjoining walls with D.D.T., malathion, or a mixture of used crankcase oil and kerosene should kill them. Make sure to check again in a week or ten days because a second treatment may be necessary.

CONFINEMENT REARING

More birds are being raised in confinement each year. One reason for this is that chicks hatched from November to January are almost fully grown before the weather is suitable for putting them on range. In some cases, losses from predators or disease have been so costly that, from an economic standpoint, range rearing is no longer practical. Another economic aspect is that the cost of fencing, equipment, and growing good pasture, and the loss of land for the production of cash crops make its use for raising pullets questionable.

In many cases, the poultry pens are empty during the growing period, yet depreciation of housing and equipment continues. The labour efficiency in most cases would favour confinement rearing.

The final answer, however, is the performance of the pullet flock in the laying pens. Many poultrymen are satisfied with their results; on

the other hand, some research has shown higher mortality and lower production compared with range-grown pullets. More experimental work must be done to determine the optimum conditions and management practices for confinement rearing.

High mortality sometimes occurs as a result of crowding and smothering at night. This loss may be reduced by getting the pullets roosting as soon as possible. Leghorns or other light breeds should have roosts (the same type used when they are adults) placed in the pen by the time the chicks are feathered, at four to five weeks of age. At first they will roost only during the day, but gradually more and more remain on the roosts at night. Once they have learned to roost there should be no problem of piling, and night lights, if in use, may be discontinued.

Confinement rearing usually results sooner or later in feather-picking and cannibalism. Therefore, at the first evidence of this, it is wise to remove the upper beak to within $\frac{1}{8}$ of an inch of the nostril, as described previously. Other alternatives after 12 weeks of age, but usually not quite so effective, are the application of plastic specs or biting the pullets.

Field observations seem to indicate that the best quality pullets reared in confinement have had at least 4 square feet of floor space per bird. Many of these flocks have had the appearance and bloom of range-reared birds rather than the dull, sheenless appearance of many confinement-reared birds.



Fig. 15—A flock of leghorn pullets being reared in confinement on a wire floor. Plenty of feeder and water space is provided. However, the birds are crowded more than would be desirable on litter.

One way to provide this extra floor space is to construct wire or slatted floor porches next to the pens, allowing the pullets free access during the growing period. For wire floors, usually 1- by 2-inch mesh electric weld 14-gauge wire is used; for slatted floors, 1-inch lumber 1 $\frac{1}{4}$ inches wide and spaced 1 $\frac{1}{4}$ inches is suitable. These platforms may be constructed on skids, thus making removal and cleaning a simple matter.

House construction is also of major importance for successful indoor rearing. The building should be well insulated and have either forced ventilation or its equivalent if it is to be cool enough for summer rearing; otherwise, losses from heat prostration and an uneven growth will likely result.

The age at which pullets reach sexual maturity is a hereditary factor but may be influenced slightly by feeding. The tendency in confinement rearing is for production to begin before the birds have developed sufficiently in size. This is the result of feeding, and of the many systems used there is considerable evidence to favour a partially restricted system. The egg production throughout the laying year was higher in experiments when this feeding program was used during the growing period. At seven to eight weeks of age, the pullets should be switched from a chick starter to a confinement growing mash, crumbles, or pellets. An all-mash program may be used or a mash and grain program, depending somewhat on the feeding method to be used in the laying pens.

A definite schedule should be followed in this program, and the following may serve as an example: full feed until 10 a.m.; the troughs empty, 10 a.m. to 12 a.m.; full feed, 12 a.m. to 2 p.m.; troughs empty, 2 p.m. to 5 p.m.; full feed, the remainder of the day.

For the success of such a program, good feed is essential as well as enough feed trough space for the whole flock to feed at once; otherwise, feather-picking and cannibalism will be a serious problem together with an uneven flock. By the time the pullets are mature, they should have 5 inches of feeder space per bird. There is a tendency for pullets reared in confinement to have soft muscles. Restricting the feeding forces the pullets to scratch and exercise more than they normally would; thus, they are stronger and better developed physically when they commence laying.

The use of artificial lights may be required depending on the season, but not more than 12 hours of light should be provided daily. All-night lighting should not be used during the growing period as it has an adverse effect on egg production.

The following table gives the results of rearing a flock of White Leghorns in confinement. Some 1,830 chicks were brooded and reared in a house 40 by 48 feet. The brooding system was infrared bulbs with oil stoves providing auxiliary heat.

FEED CONSUMPTION AND MORTALITY FOR W.L. PULLETS REARED IN CONFINEMENT

Period	No. of Birds			Total Feed	Feed per Chick lbs.
	Started	Mortality	Culled		
0 - 7 wks. (chick starter crumbles)	1,830	47	....	6,850	3.84
8 - 20 wks.	1,783	59	151	28,500	18.11
0 - 20 wks.		106	151	35,350	21.95

STARTED PULLETS

The started pullet business is on the increase. Some growers make a specialty of producing pullets for sale at ages between 12 weeks and ready-to-lay. Commercial egg producers buy started pullets in order to keep their pens full of producing birds. In some cases they have contracted to supply eggs, and started pullets help them to maintain a constant supply of eggs.

Purchase of started pullets was frowned on in the past because of the disease hazard and the possibility of merely acquiring someone else's culls. It is still necessary to make certain that the grower is using chicks from tested laying strains and following a good program of feeding and management. In most cases a definite vaccination program is followed. The selling price will vary somewhat with the number and age of birds. Started pullets are available at prices well in line with actual production costs.

HOUSING PULLETS

The age at which a pullet will lay her first egg is determined by heredity and will vary with different strains. Feeding methods will alter it only slightly. Provided the laying house is well insulated, it will probably be cooler than the range for early hatched pullets. The pullets should be housed before they commence laying. This time will be indicated by the enlargement and red appearance of the comb and wattles; the abdomen will also begin to let down and feel soft and pliable. Along with these physical changes, the temperament of the pullet also changes; she becomes quieter and starts searching for a place to make a nest.

All possible precautions in handling should be taken when moving pullets into the laying pen because it is a sudden environmental change.

Methods of Moving and Management

There are a number of methods to get the pullets from range to laying pens and of these getting them to walk in is the simplest. If the range is located near the poultry house, do not feed them at their regular time; let them get hungry, then scatter some grain from the range to a snow-fence enclosure by the door of the pen; as the pullets follow the grain to the enclosure, they may be driven into the pen. By following this procedure, all but the wildest pullets may be housed in a few days with very little time or labour involved, and it is easy on the birds. A second method when the range is not too distant and when range shelters are

used is to draw a shelter full of birds up to the house, then transfer them. This means that the shelters should be constructed on skids and probably not larger than 6 by 8 feet; otherwise, they would contain too many birds and some might smother.

A third method is the use of a catching pen (see Fig. 16) which is constructed to fit against the front of the shelter and is approximately 6 feet wide and 6 feet 6 inches high. A few birds may be let out of the shelter at a time and caught and passed through a small door to be culled and crated. This catching pen saves the back of the man catching and prevents the piling of the pullets, which normally would occur in the end of the shelter. A few birds may be let out at one time and caught and passed through a small door to the culler. The catching pen is light enough for two to carry.

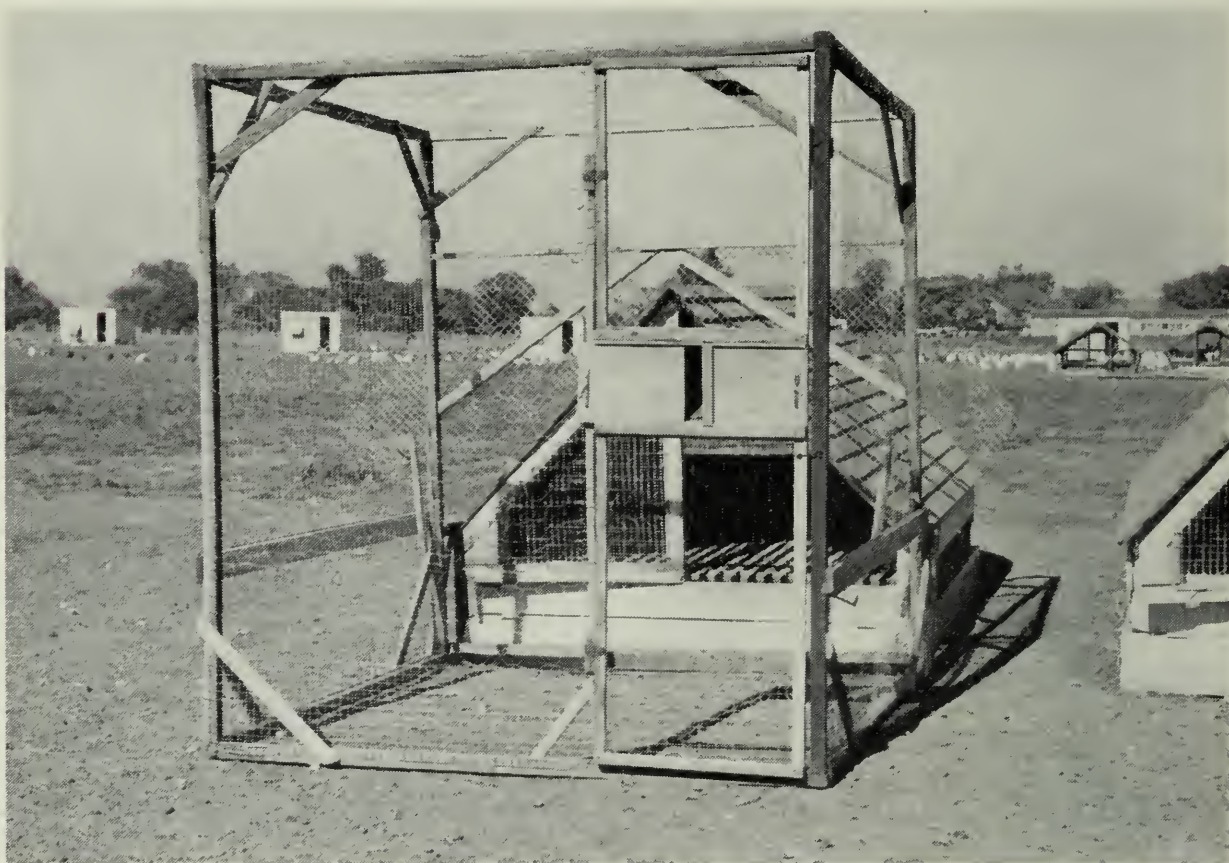


Fig. 16—A catching pen. Heavy wire is used around the bottom to give added strength.

Catching pullets in colony houses may be most easily done by placing two or three catching crates before a small door of the house and driving the pullets out of the house into the crates. A low trailer for moving the birds to the laying pen saves much lifting. Regardless of the way the pullets are moved, make sure you do not leave them shut up and crowded in hot weather. It may be possible to move small flocks at night; for large flocks, plan on getting an early start and, if the weather is hot, let out any birds not moved by about 10 a.m.

The environmental change from range to laying pen is quite a shock for a pullet; hence all unnecessary handling and changes in feeding and

management should be avoided until the pullet becomes accustomed to the new surroundings.

Extra attention the first few days after housing may save considerable trouble later on. Feed troughs and waterers the same as those on range should be placed in the pen until the pullets become accustomed to the regular laying pen equipment. Having these extra waterers on the floor may go a long way in the prevention of blue comb.

The first few nights after housing it may be necessary to catch some pullets and place them on the roosts; otherwise, they will remain on the floor, never learning to roost. When putting pullets into the laying pen, if at all possible put them on the roosts rather than the floor. The first night the majority will then go to roost themselves, whereas if thrown in on the floor of the pen, the majority will sit in corners and have to be caught and put on the roosts. While some poultrymen do not use roosts in their pens, this usually results in damper litter, and there is a danger of the birds sitting in groups and becoming overheated in warm weather, which could result in respiratory disease.

The same feed used on range should be fed after housing until the pullets have come into production. The change to a laying ration should then be made.

FEEDING LAYERS

All Mash—This method is suitable for houses with mechanical feeders or for inexperienced poultrymen. Laying mash is available which is designed for “all mash” feeding. This mash (or crumbles or pellets) should be available to the flock at all times, and no grain should be fed with it. In some cases, free-choice oyster shell should be available; in others, enough calcium has been added to the ration.

Grain and Mash—Mash should be before the birds at all times, but be sure you give them only the amount they will clean up each day. Never add new mash on top of old; either move the old mash to one end of the trough or sprinkle it on the new mash. Grain fed with mash is usually given at night and should be fed proportionately by weight with the amount of mash consumed. Usually a 20 per cent protein mash is fed 50-50 by weight with grain. This will vary, of course, according to the size of the pullets and rate of production. Since pullets keep on growing until they are almost one year old, it is wise to mark some birds in each pen and weigh them periodically because once they start to lose weight, production will slip in about two weeks' time. The maintenance (feed requirements to maintain body weight but not sufficient for egg production) of 100 Leghorn pullets is approximately 15 to 17 pounds of feed per day; as production increases, so should feed consumption.

Feed consumption varies with the size of bird—the bigger the hen, the more feed she requires. As the rate of lay increases, the flock eats more feed, but the feed consumed per dozen eggs is less. In a test at O.A.C. in 1954, feed consumption by various breeds and crosses was as follows:

EGG PRODUCTION OF LAYERS ON A FORTY-WEEK TEST

Strain or Cross	Percentage Production Hen Day	Per Dozen Eggs (lbs.)	Consumption per 100 Birds per Day (lbs.)
Inbred Cross	64	4.32	23.03
R.I.R. (R.O.P.)	62	5.27	27.18
R.I.R. x L.S. (Dual)	61	5.45	27.76
N.H. x C.R. (Dual)	57	5.70	27.19
B.R. (R.O.P.)	54	5.81	26.46
W.L. (R.O.P.)	48	5.88	23.71
N.H. x W. W. (Dual)	51	6.10	26.01
N. H. x B.R. (Dual)	56	6.10	28.48
W. R. (Meat)	49	6.64	26.94
B.R. (Meat)	48	6.80	27.99
N.H. (Meat)	48	7.44	23.96

This table clearly illustrates the efficiency of egg strains over meat-type birds for egg production. It must be remembered that both meat strains and egg or dual-purpose strains may occur in the same breed. Moreover, the pounds of feed per dozen eggs is not the whole story because egg size varies. A comparison of pounds of feed per pound of egg would give a truer picture. High production calls for full feeding. If for any reason the flock goes off feed, a noon supplement of 3 pounds of mash either in pellet or moist mash form per 100 birds will sometimes get them to eat more, but, once started, this practice should be continued. Grain Mixture: Probably the most common grain mixture is one containing one part of oats and two parts of wheat by weight. In some areas, barley is available and may be used in amounts up to one-third of the grain mixture.

New Grain—New grain poisoning is always a threat each fall. As a precaution, it is wise not to feed new wheat until about November, and then start off with not over 10 per cent, then gradually increase if no harmful effects are noted.

Oyster Shell—This should be fed free choice in separate hoppers unless, as mentioned, the feed company has added enough calcium to the ration. In this case it is not necessary to feed oyster shell.

Grit—An insoluble type of grit should be fed to birds which are getting grain. It is questionable if it is necessary to feed grit to birds on an all-mash ration. Grit may be fed free choice or sprinkled on top of the feed in the troughs twice a week. A laying hen requires about .7 pounds of insoluble grit a year.

Water—Plenty of clean, fresh water should be available at all times. Many different types of automatic waterers on the market are giving

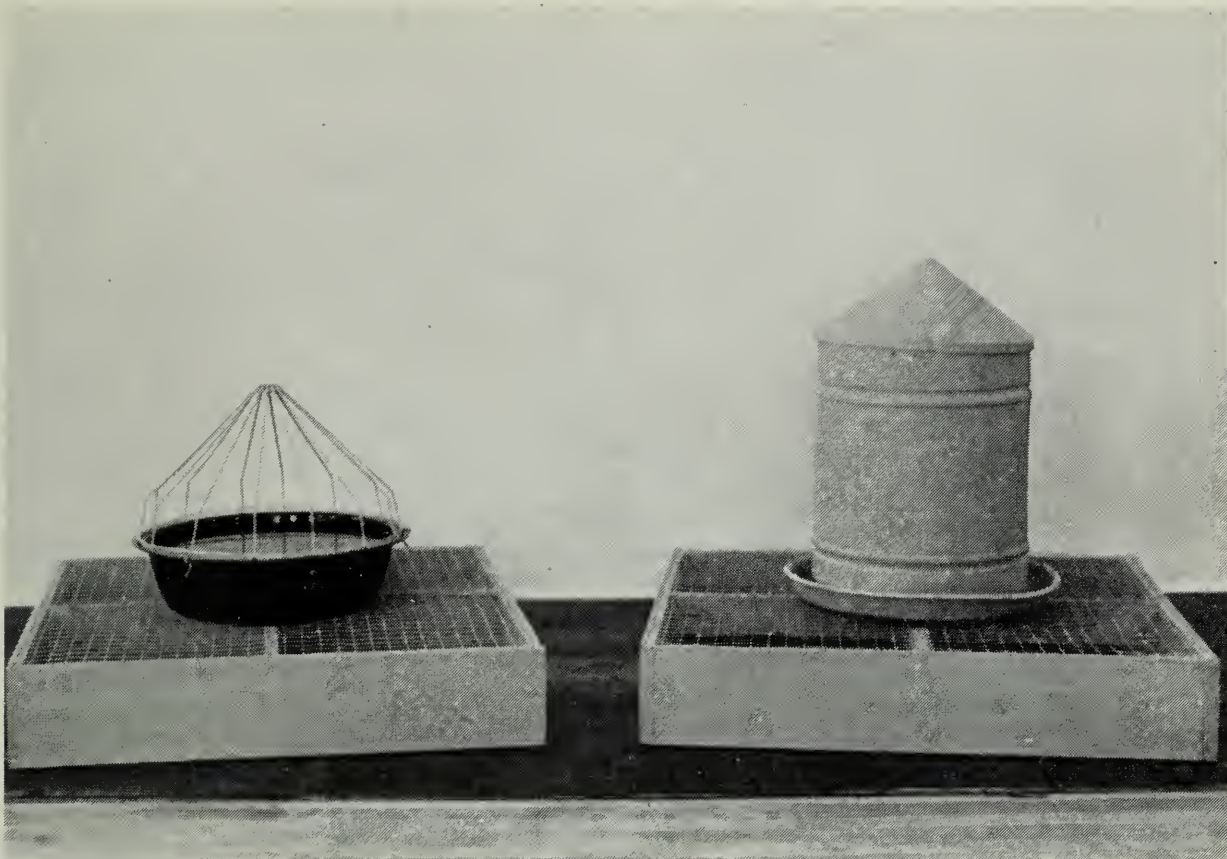


Fig. 17—Types of waterers and stands used when water pressure is not available.



Fig. 18—Plenty of trough waterers are used in this pen—a row between the posts and others between the feed trough and wall.

satisfactory results. One hundred layers will consume 4 to 6 gallons of water daily. Using this as a basis, a general recommendation would be one 10-gallon waterer or one automatic waterer for each 150 birds. Common sense should be used, however, because in hot weather it will pay to provide extra waterers. Similarly, in cold winter weather it may be advisable to use some type of water warmer. It is also a good idea to locate at least some of the waterers on the pits.

LAYING PEN EQUIPMENT

Feed Troughs—The type of trough used is not too important; however, the way it is used is important. Overfilling the troughs results in a high feed wastage, which should be prevented. To keep wastage at a minimum, never fill the trough more than half full. Provide 48 linear feet of trough for each 100 heavy breed layers. Feed wastage may be reduced by keeping the lip of the feed trough level with the bird's back; this is especially true when using hanging feeders.

Nests and Nest Litters—The type of nests more commonly used are: individual, community, sloping wire floor, nesting rooms, and trapnests used for pedigree breeding.

Probably more individual nests are used than any other kind, and one nest should be provided for every five hens. The nests should be of ample size (12 inches wide by 14 inches high by 12 inches deep). The hens usually prefer this type of nest, provided they are properly located.



Fig. 19—Hanging feeders being used with trough feeders. The use of some feeders over the pit should help maintain good production.

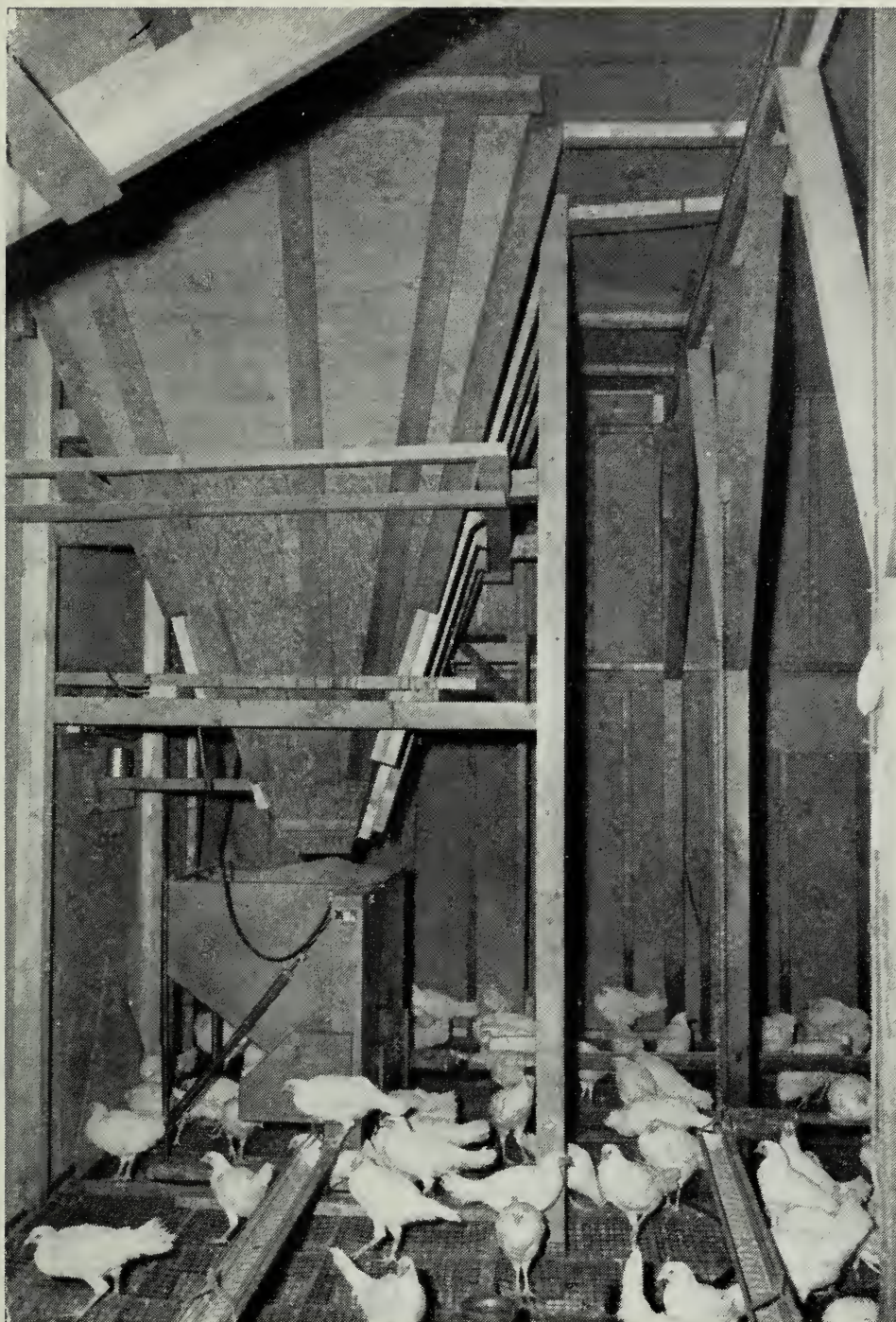


Fig. 20—Mechanical feeder arrangement using bulk feed.

The disadvantages of the individual nests are that more nesting litter will probably be required because the birds scratch it out readily and, in some cases, more time is required for gathering eggs. As these nests tend to let in a lot of light, pickouts can be a serious problem.

The mention of community nests to a group of poultrymen usually starts an argument because some have no use for them and some would use no other type. A community nest 4 feet wide by 14 inches high at the front by 2 feet deep, which slopes to a height at the back of 30 inches, with 8- by 8-inch opening in the front, will provide nesting space for 50

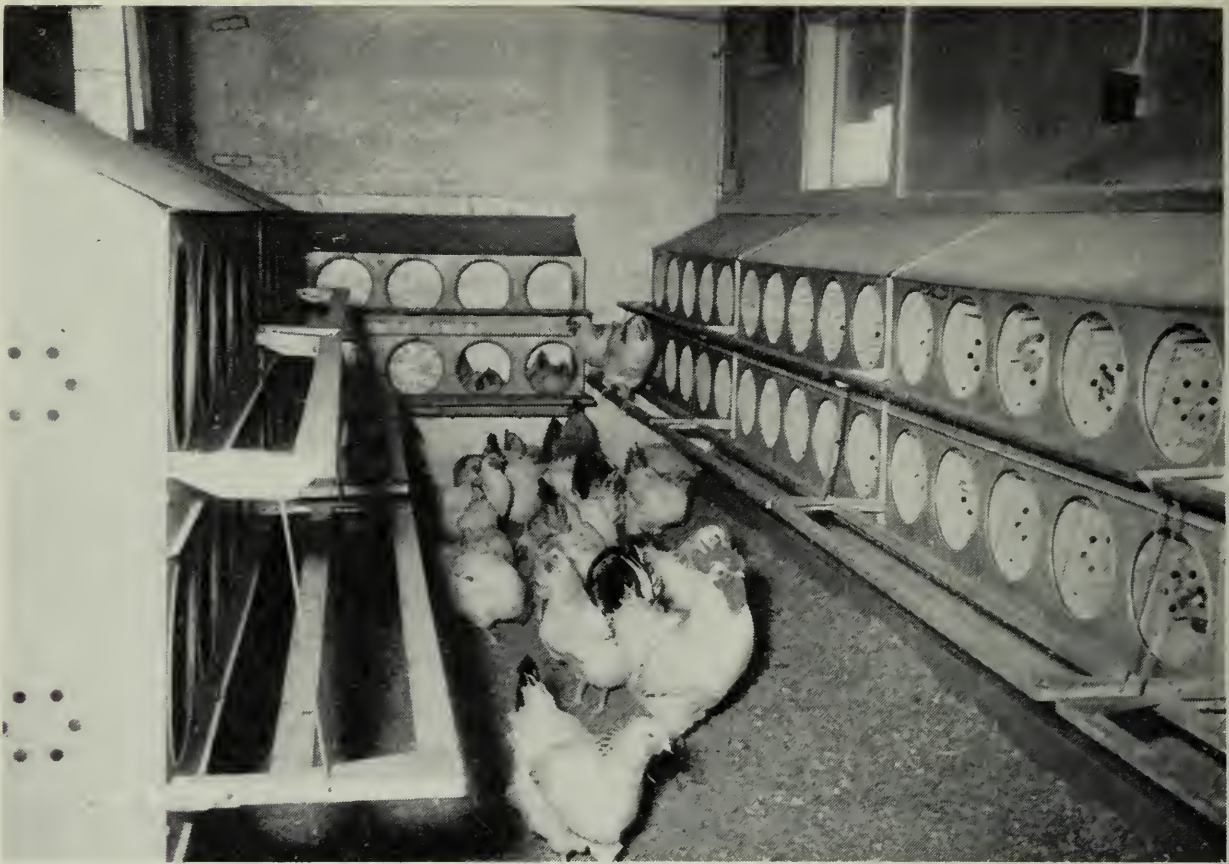


Fig. 21—Individual nests arranged for efficient egg gathering.



Fig. 22—Community nest showing dimensions.



Fig. 23—Community nests eight feet long, with a partition in the centre.



Fig. 24—A nesting room showing nest arrangement.

hens. As with the single unit, they may be constructed in longer sections with partitions and in tiers. A good depth of litter, say 4 to 5 inches, should be maintained in this nest for clean eggs and a low percentage of breakage. In extremely hot weather, the top section may be moved out from the wall to allow better circulation of air.

The lighter breeds, such as Leghorns, take to a community nest better than the heavier breeds. In any case, these nests should be available for the birds when they commence laying. If you switch from an individual-type nest to a community nest, the percentage of floor eggs will go up immediately.

The sloping wire floor nest is a modified type of community nest. The wire floor slopes to a gathering compartment in the front. It usually requires considerable time to train the birds to lay in this nest and they do not like the wire floor. At first it is often necessary either to cover the wire floor with litter or to pack the space between the wire and bottom of the nest with litter. The wire bottom does not necessarily mean that the dirty egg problem is solved as the dust from the pen and dirt from the birds' feet may still mark the eggs.

Nesting rooms or closets, while not extensively used, have advantages because hens like to find a somewhat darkened area in which to lay their eggs. The ideal setup for the nesting room is the house with a feed room in the centre and one pen on either side. In most cases where the feed room runs the full depth of the house, there is waste space at the back which just becomes a catchall for little used and old equipment. This space could be put to better use as a nesting room.

The walls and end of the nesting room are lined with nests. The birds will travel up to 75 feet to lay in this type of closet. The labour in collecting eggs is reduced considerably, but some operators object to the fact that the caretaker is not in the pen so often to see that everything is in order.

Regardless of the kind of nest used, if the floor litter is wet, dirty eggs will be a problem. The kind of nest litter used also has an effect on the cleanliness of eggs produced. Tests on egg cleanliness, labour requirements for nest maintenance, and durability of nesting material favour shavings, sawdust, and straw, in this order.

The nest location is one factor which is more important than commonly believed as a factor influencing the cleanliness of eggs produced. Regardless of having dry floor and nest litter, if the nests are not located so that you obtain uniform nest usage by the flock, the percentage of dirty eggs will increase.

Factors to be considered in nest location:

1. The nests should be located in the darkest section of the pen or so constructed that they may be darkened.
2. It is essential that all nests are in the pen before the pullets are housed. If the pullets are laying 25 per cent, they will not require so many nests as they will when they reach 70 per cent production. However, if you wait until they reach 70 per cent production before putting in all the nests, you will find that you collect very few eggs in the more recently added nests.
3. The ventilation system must also be considered. Too much breeze (particularly true when fan ventilation is used) will result in the birds laying in other nests.
4. The daily concentration of the birds in certain sections of the house results in heavier use of some sections of nests.

Artificial Lighting

Research has shown that while artificial light does not increase annual egg production, it does make it possible to get more eggs when they are wanted.

Additional light during the shorter daylight hours of fall and winter stimulates the pituitary gland. This gland produces a hormone, which in turn stimulates the reproductive organs, thus bringing about increased egg production. The light intensity needed to stimulate egg production is not great.

For best results when using artificial light:

1. Provide one 40-watt bulb for each 200 square feet of floor space and make sure all the pen is uniformly lighted.
2. Locate the waterers and feed troughs in the brightest part of the pen to assure maximum feed and water consumption.
3. Do not give layers more than 13 to 14 hours of light per day.
4. Use morning lights, provided the water cannot freeze, and make sure feed is available.
5. Start a pullet flock with 12 hours light, then increase to 12½, 13, 13½, and 14 hours as production levels out or starts to slump.

Lights are beneficial:

1. When pullets go into a slump.
2. When pullets are late maturing.
3. To squeeze the last few eggs out of old hens.
4. To get early eggs out of moulted hens.
5. Any time it is desirable to hasten production.

Producers raising late-fall-hatched chicks for layers should not use 24-hour lights during the growing period because this will inhibit the expression of sexual maturity of a considerable number of pullets and prevent a high rate of intensity of lay during the entire laying year.

Observations are that October and November hatched pullets outlay the same strain of pullets hatched in January or later. The explanation appears to be light as both groups are confinement reared. The October and November hatches do not receive as much natural light stimuli as the January hatches receive until nearing sexual maturity, thus respond better to light in the laying pen.

Research, as a result of these observations, has demonstrated that fall hatched pullets will peak in production faster and maintain a higher rate of production over a period of lay if they are restricted to eight hours of light per day from ten to twenty weeks of age.

Florescent lighting, while more costly to install, requires approximately half the electric power to operate. For this reason, it is probably economically sound to use over a period of years.

EXTERNAL PARASITES

The Common Red Mite can be controlled in the manner mentioned under "Rearing". However, if no roosts are used, a 4 per cent malathion dust may be sprinkled on the litter.

The Northern Fowl Mite is a small black mite appearing as a black speck on the plumage. This parasite lives and reproduces on the bird and gets its food by taking blood from the host. The eggs are deposited and hatch among the feathers and generally may be found about the base of the tail and the vent. Their habit of choosing certain local areas as "feeding grounds" causes the formation of large scabs which spoil the appearance of the dressed carcass. Heavy infestations result in lowered egg production and, if unchecked, some mortality.

This mite is much more difficult to control than the common red mite. Three or four treatments at three-day intervals of nicotine sulphate 40 per cent applied to the roosts in a thin strip twenty minutes before

the birds go to roost should prove effective. Make sure the pens are well ventilated if this treatment is used.

For flocks not using roosts, an application of 4 per cent malathion dust on the litter and in the nests is very effective. The amount used is one pound for twenty square feet of floor space. For small flocks, individual bird treatment with sodium fluoride or other commercial dusts applied to the fluff above and below the vent of infested birds gives excellent results.

Lice—The ordinary chicken louse which spends its life history on the bird may be controlled by using the same treatment given for the northern fowl mite.



Fig. 25—Egg clusters of the body lice on feathers from the abdomen.

CANNIBALISM

Most commercial egg producers find that it saves time, when they house their pullets, to remove part of the upper beak with an electric cauterizer or to put plastic hen specs on them. Beak clipping done with an electric cauterizer should last throughout the laying year provided the upper beak is removed to within $\frac{1}{8}$ of an inch from the nostril; the tip of the lower beak should then be seared to retard growth. Specs work in some cases and not in others, but may be applied much more rapidly than clipping a flock's beaks.

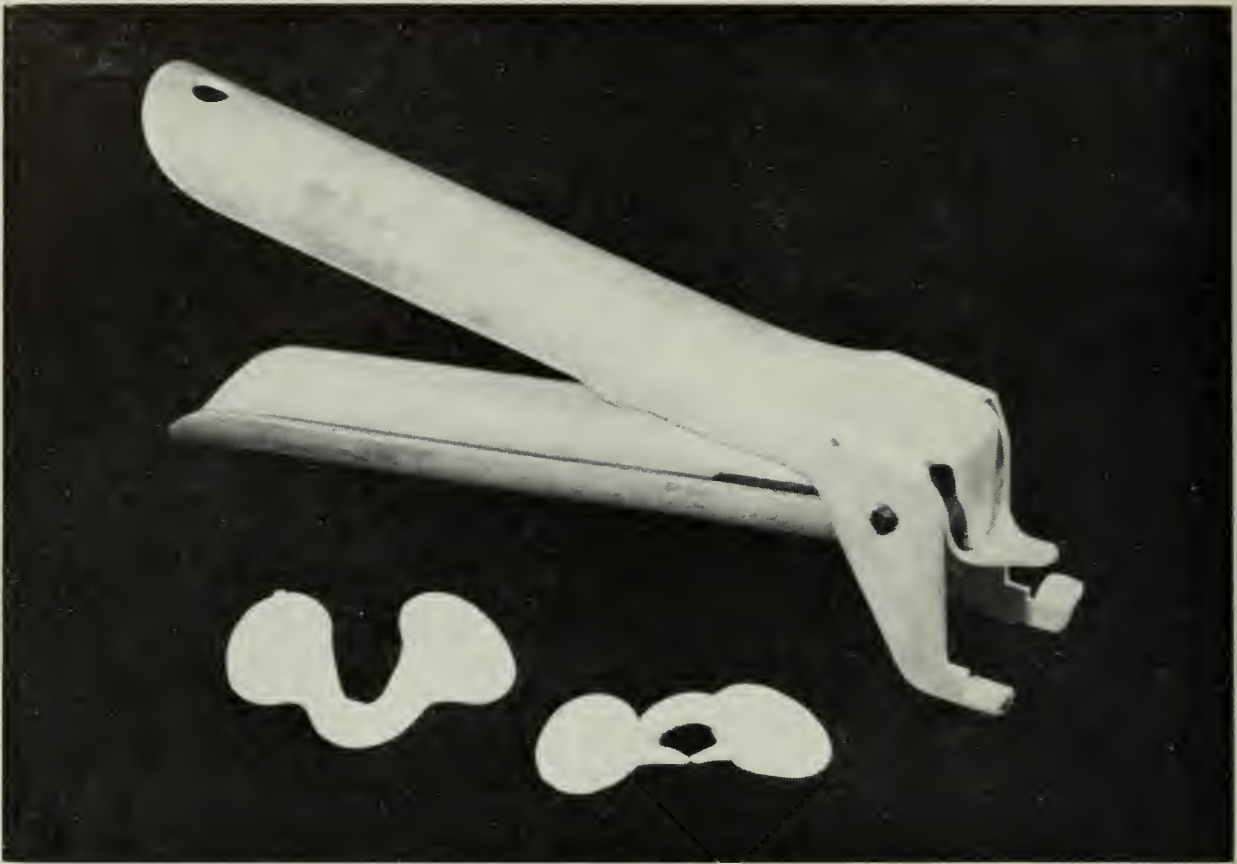


Fig. 26—Plastic specs and applicator.



Fig. 26-a—Showing the application of a spec.



Fig. 26-b—Hen with spec which prevents forward vision.

VENTILATION AND USE OF FANS

Excessive dampness is a winter problem in many poultry houses. Wet litter means more work in cleaning eggs and stirring litter, and unpleasant working conditions in pens where ammonia fumes are probably strong. The chickens, as well as the poultryman, suffer under such conditions.

Dampness in litter is the result of accumulation of water in the droppings, in the air exhaled by the birds, in water spillage around the waterers, and in snow and water blown in open windows or tracked in by the attendant. The combined water from these sources with 100 layers would amount to 4 to 6 gallons daily.

If the water is to be removed by the ventilation system, it must be in vapour form. Heat is required to change water to vapour. The main source of heat in a poultry pen is that given off by the birds. Other sources of heat are from decomposition of the litter and from sunshine.

Since the bird is such a small unit, it means that there is very little heat available to convert the water to a vapour unless artificial heat is used. The moisture-carrying capacity of air doubles for every 20°F. by which its temperature increases. This has resulted in an evolution in

poultry housing from open-front houses, straw lofts, etc., to insulated houses with restricted ventilation. All these systems have their faults, and different systems are still being tried. The restricted ventilation system will work in large houses provided the birds are not crowded and the ventilation is adjusted with changing weather conditions. Its success then depends on the operator.

In recent years the University of British Columbia has been experimenting with electrically heated cables in the concrete floor of poultry houses. It was successful in keeping the floor dry but required an insulation under the cable and a minimum of litter on the floor in order to get the maximum drying action.



Fig. 27—A hen which has just had its beak clipped and cauterized.

The rising costs of poultry house construction have resulted in flock owners crowding their birds. This increases the animal heat available for vapourizing moisture, but restricted ventilation can not handle this increased moisture. To overcome this problem, a number of poultrymen have installed fans with favourable results.

Fans alone are not the solution, however, since to be effective the house has to be well constructed and insulated. Fans have several advantages.

1. Being thermostatically controlled, fans reduce the labour required to adjust windows, etc.



Fig. 27-a—This shows the long lower beak. It may interfere with normal feeding and therefore should be cut back.

2. The resulting drier litter means less stirring, less egg spoilage, and lower litter costs (it will not be necessary to add new litter so often).
3. Conditions for both the birds and the attendant are improved by the reduction of ammonia fumes.
4. Fans properly located will prevent drafts on the birds.
5. The removal of the moisture will lengthen the life of the building and equipment.

Following are some points to consider in installing an exhaust fan:

1. Fans are usually installed to provide 3 cubic feet of air per minute (C.F.M.) for the average light breed hen. Another method is to provide an air change within the pen every five minutes. A more flexible ventilation system usually results if several small fans are used, rather than one large fan. The above recommendations must be tempered with common sense because there are so many variables. The type of house, number of birds, size of birds, season of the year, and district of the province are some of these variables.



Fig. 28—Extra mow space has been converted at low cost to poultry pens. This shows the windows used for ventilation. Windows in the back wall are opened in summer to provide cross-ventilation.

2. Have the fans thermostatically controlled and locate the thermostat away from the fan. Near the centre of the pen at eye level is the best site.
3. Have inlets which are adjustable. The area in inlets should be approximately four times that in exhaust openings.
4. Make sure the poultry house is well constructed and well insulated.
5. Install the fan at ceiling height not too close to any openings.
6. Select a good exhaust fan with automatic shutter to close off the opening when it is not operating.
 - (a) Make sure it has a dust-proof enclosed motor with overload protective devices.
 - (b) Install a wire mesh guard if it has not one. This is merely a safety device.
 - (c) Get a corrosion-resistant, cooling-type thermostat. Remember, a fan will not substitute for poor building construction or for poor management practices. It is necessary to learn how to operate the fan since the thermostat will probably have to be set differently for each season and the intakes adjusted. Try to maintain a pen temperature above 45°F. Keep all screens around the fans clean because enough dust will eventually accumulate to reduce the fan's effectiveness.



Fig. 29—A pole barn with exhaust fans provided in the ends and sides for winter ventilation. In warm weather, only the windows are used for ventilation. This building is reasonably well insulated.

Litter and Litter Management for Layers

The old idea of having shallow litter and cleaning the pens regularly has gone the way of the dropping board. Too much labour and litter were required, and it was discovered that insulated and deeper pens could actually be kept drier by using a built-up litter and droppings pits and by cleaning out the pen only once a year. Some have gone even further and leave the litter in the pen for a number of years, adding new litter periodically. This type is often referred to as compost litter. There is no doubt that compost litter is easier to keep dry than built-up litter; however, it has other disadvantages, with the result that most poultrymen prefer to use built-up litter and an annual cleanup.

The characteristics to look for in good poultry litter are absorbency, ability to give up moisture readily, low dust content, availability, and a reasonable price. While all of these characteristics are desirable, the deciding factors are availability and price. Since most litters will work satisfactorily if handled properly, it is only common sense to use a litter which is available locally and therefore usually cheaper than imported litters.

Straw and shavings or combinations of them are probably the most widely used. Since straw absorbs moisture through the ends, cut straw is preferable. Shavings, while low in ability to absorb moisture, are flaky enough to allow air circulation, thus giving up moisture better than many litters.

Peat moss is expensive in most areas. It is very dusty when dry. Peat moss has a higher moisture-absorbing capacity than most litters, but it mats when wet, thus holding the moisture.

Peanut shell litter has been used to a limited extent in brooder houses, but again it is expensive and mats much more readily than shavings.

Corn cobs, if free from moulds and put through a hammer mill, have all the desirable characteristics of good litter and, in corn-growing areas, are the logical litter to use.

By September, consideration should be given to the type of litter to be used in the laying pens throughout the winter. In the great majority of houses this means straw and/or shavings for built-up litter. Different methods are used to obtain good built-up litter, depending on the particular flock management. The most common system is to start with a good depth of new litter in the pens when the pullets are housed. Additional litter is added when required until, by the end of the year, it probably will have built up to a depth of approximately one foot.

Those operators using the same house for brooding and for the laying flocks have an advantage in that they can leave the chick litter as a base for the built-up litter. When the pullets are ready to house, new litter may be placed on this old litter and more added throughout the laying season as required. Similarly, with pullets reared in confinement, one should maintain shallow litter throughout the summer, then add to it when the summer heat is over.

With good housing, ventilation, and management, either of these systems should serve to maintain dry litter throughout the late fall and winter months. The reason for this is that there is a good buildup of bacteria and moulds before cold, damp weather starts. These bacteria and moulds require moisture and cause some heating of the litter; thus it stays drier.

The poultryman most likely to have a problem with damp litter, and this includes the majority, is the one housing pullets in a pen with completely new litter. Considerable time is required for the litter to break down and the bacteria to build up.

Litter may be started in different ways, some operators preferring a base layer of sand. It is doubtful whether there is any benefit in this, and it makes the pen more difficult to clean the following year because wet sand is heavy to shovel and does not wash out easily with the water pressure available on most farms.

This brings us back again to the use of cut straw or shavings or a combination of the two. Regardless of which you use, an approximate depth of six inches of litter should be placed over the floor at the start. Incidentally, where droppings pits are used, a coating of litter over the floor of the pit helps to prevent the droppings from sticking to the floor.

The litter gradually breaks down and, as more is required, the simplest method is to place a few bales on the floor in the front of the pen and allow the birds to spread them.

The periodic addition of new litter is no guarantee that the litter will remain dry even when the house is well ventilated. The birds always face the light when scratching, which usually means there is little or no litter in the front of the pen and for a foot or more in the back section or next to the pits. Litter acts as floor insulation, and it is essential that a uniform depth be maintained at all times; otherwise, condensation will take place on the bare areas—a prime cause of dampness. To keep the litter evenly spread and to prevent it from packing, it is

necessary to fork it over whenever these conditions arise; this may mean two or three times a week in damp weather. Throwing a little scratch grain in the litter will make the birds more active, thus helping to keep the litter loose, but not of uniform depth.

Problems with damp litter usually start around the water fountains, and this litter may have to be replaced. A better solution is to place the waterers on well-lighted sections of the pit so the spill will go into the pit instead of the litter.

Do not wait for the litter to become wet! At the first sign of dampness, scatter hydrated lime over the litter at the rate of 1 pound per 4 square feet of floor space and stir it in. The hydrated lime has a physical and chemical action which helps to keep the litter dry and prevent packing.

There have been reports that superphosphate will dry out litter, but tests at the O.A.C. indicate its use will result in damper litter (more than 50 per cent moisture) than that in pens where nothing is added to the litter. Superphosphate does fix nitrogen, however, thereby reducing ammonia fumes. It should be used only in the droppings pits at the rate of approximately 3 pounds per 100 layers and, to be effective, it must be used regularly.



Fig. 30—An excellent example of built-up litter.

MANAGEMENT OF THE BREEDER FLOCK

Selection

The breeder must, of course, establish a breeding program if he hopes to improve his stock. Regardless of the breeding program, however, it is necessary to cull the pullets before they go into the breeder pens. Pure-bred matings require special selection for type and uniform size for the strain in addition to the removal of deformed and weak pullets, as well as those with standard disqualifications. The pullets left as breeders should then be blood tested for pullorum disease.

The selection of cockerels should be done more rigidly than for pullets. A good cockerel must be particularly vigorous and active, of desired type and size, and free from standard disqualifications. The cockerel should also be pullorum-tested.

Management

The management of a newly housed flock of breeders is quite similar to that of a flock producing market eggs. Instead of forcing production, however, the flock owner attempts to get the bulk of his eggs during the hatching season.

Unless eggs are wanted for fall hatching, the usual procedure is to allow the pullets to come up in production naturally without the use of artificial light until production has levelled off and is showing signs of dropping. Lights should then be provided fourteen hours a day.

Feeding

A hatching ration should be fed at least two months before eggs are to be saved. In actual practice, most flock owners switch directly from grower to a hatching ration, rather than feed a laying ration for a short while and then make another change in feed.

It is essential that feed consumption be kept at a minimum level. This can be done only by keeping track of daily feed consumption, since a drop in feed consumption is one of the first signs of trouble. This calls for immediate action in seeking the cause and trying to remedy it. A flock which is losing weight and condition is a poor prospect for breeding and hatching.

The cockerels in a flock are an added problem since they, too, must be in good condition. One way to accomplish this is to have a few feed troughs with grain or fitting ration at a level too high for the hens but not for the cockerels. If an all-mash ration is being fed, use pellets rather than grain as supplementary feed for the cockerels.

Growing Cockerels

Seven cockerels should be housed with every hundred pullets and as not all cockerels are suitable as breeders, this means it is quite an expense to raise a cockerel. For the average size flock, the cockerels should be hatched at the same time as the pullets and raised with them.

As day-old chicks, Leghorn or other light-breed males should be dubbed. If your flock is entered in a government policy, permission to do this should be obtained. Dubbing can be done by cutting the comb off with manicure scissors.

At eight to ten weeks of age the cockerels should be moved to range, depending, of course, on the season. This handling offers a good time to cull them, and about one-third to half of the number should be culled. Since pigmentation is a good indication of vigour, remove any pale-shanked birds. Undersized, fine-boned birds should also be culled in addition to cockerels with coarse, rough-scaled shanks. They may be managed and fed on range in the same manner as pullets and will be less trouble if raised with the pullets.

By the time cockerels are about four months old and beginning to mature, fighting will be a problem, and they will pick on the weak birds. Almost all that can be done to prevent this is to provide shelter such as corn or other cover where cockerels can hide.

If the cockerels were not dubbed at the age of one day, it may be done at this time, with the lower two-thirds of the wattle being removed at the same time. If it is done properly, there should be no mortality. The bleeding may be kept to a minimum by cutting the comb from front to back along the line of indentation (just above the thick part). Sprinkling the cut surfaces with powdered alum also reduces bleeding. A pair of shears are usually the most effective means of making the cut. The combs and wattles will then be healed by the time the cockerels are ready to house, which should be at the same time as the pullets.

It is wise to put one or two extra cockerels in each pen because it is almost impossible to add new cockerels at a later date.

In some cases, breeds of cockerels are changed during the hatching season. This is a questionable practice because putting different-coloured cockerels in a high-producing pen may frighten the hens enough to put them off production. Another disadvantage is that no eggs should be saved for two to three weeks after making the change as the fertility from the first lot of cockerels could carry over this length of time.

Government Supervised Poultry Breeding Policies

The federal government supervises the "Canada Poultry R.O.P." under the supervision of the Livestock and Poultry Division of the Production

Service, Department of Agriculture, Ottawa, Canada. The provinces each have a supervised policy for the flocks which supply hatcheries with eggs.

In Ontario the policy is called "Ontario Poultry Approval Policy" and is supervised by the Department of Poultry Husbandry, Ontario Agricultural College, Guelph, Ontario. Flock owners or the hatchery to which they ship eggs must make application annually between June 1st and September 1st. The breeding flock is selected and pullorum-tested by qualified persons—employees of the Department of Poultry Husbandry and working under its supervision.

WIRE AND SLATTED FLOORS

As one of the various systems tried for increasing bird density in laying houses, the use of wire or slatted floors apparently has caught on quite rapidly. The final answer to their use is a matter of economics. At the present time it would appear that birds may be carried at a density of one square foot of floor space per bird with this system; in other words, the equivalent of three floors of birds in one. As a result, more efficient use is made of labour. From the standpoint of usage of equipment it is well adapted to automation such as mechanical feeders and egg gatherers, automatic waterers and forced ventilation; in fact prefabricated windowless houses with wire or slatted floors are available. This type of house with complete automation can probably result in one person looking after up to 12,000 layers. This may require staggering of lighting so that half the flock produce the bulk of their eggs in the forenoon, the remainder of the flock in the afternoon. This of course requires a windowless house.

The cost of installation of these floors must be considered. The wire floors are approximately 28¢ per square foot, the slatted floors approximately 10¢ more per square foot. Both types should be constructed in portable sections that one person can handle and should be a minimum of 24 inches above the floor of the building. The frame for the wire floor is 2- by 4-inch with 1- by 3-inch cross frame every 16 to 18 inches. Eleven or twelve gauge 1- by 2-inch or 1- by 4-inch electric weld wire is stapled to the frames. Regardless of how tightly this wire is stretched it soon sags, making it awkward for the attendant to walk on.

Slatted floors on the other hand do not sag. The slats are usually ripped from 2 inch planks and are approximately $\frac{5}{8}$ inch in width, while the length varies. The slats are placed on their edge in slots with enough clearance so that they wiggle. This eliminates any danger of the droppings caking and allows simple replacement of broken slats. The framework is 2- by 4-inch.

The big labour requirement comes when it is necessary to clean out the pen, whether wire or slats are used. If a steam jenny is available, this is not much of a problem. Otherwise it is necessary to take all the sections outside and allow them to become rain soaked or washed with water pres-

sure and a brush. The removal of the litter itself may be done with a tractor and bucket scoop.

There are a number of advantages with this type of poultry house, the main one as previously mentioned being efficient use of labour. Second is that no litter need be bought, a considerable saving for a large operator. The third factor is that pens which are poorly insulated will often prove satisfactory during winter because of the high bird density, although this can result in a ventilation problem in summer weather.

Unfortunately there are still a number of nutritional and management problems to be overcome. There is a tendency for birds on wire or slatted floors to become fat which may indicate the need for special rations. Keeping the feathers on these birds is another problem. It probably starts out as feather picking, then the birds become bare and get a chill in severe weather. This has resulted in a serious drop in egg production, the flock in some cases going through a moult. The problem of birds roosting on feeders, nests, waterers, etc., has been difficult to overcome in many cases. One solution is to install tumble bars or some similar deterrent on the equipment. It is desirable to spend extra time with the birds the first few days when the lights go off, in order to establish a routine for the birds. Floor eggs have also been a costly problem with a few operators. For some reason, the pullets do not always take to the wire bottom nests. This may be overcome by placing litter on top of the wire bottom of the nests or by placing the nests on the floor until the pullets start using them. There is excessive breakage and soilage of floor eggs in this type of set-up. Dirty eggs are not a problem, however, once the birds start laying in the nests.

The use of wire and slatted floors in Ontario has not been carried on for a long enough period to have definite information regarding egg production that may be expected. In some cases, flock production over a twelve month period of lay has been very disappointing, in others quite satisfactory. From a number of general comparisons between litter and wire or slatted floors, egg production seemed to average approximately 5% lower on the slats or wire. This does not mean, however, that net profits were lower, because the increased density and labour efficiency favours the wire or slats. One thing that one must keep in mind is that it takes a better manager to have success with wire or slatted floors than is the case with birds on litter.

LAYING-CAGE OPERATIONS

Advantages

1. Efficient culling, regardless of poultry experience.
2. Cannibalism is not a problem.
3. Lower mortality.
4. Individual records easy to keep.
5. Can work out an orderly management program giving the individual birds more attention.
6. Feed conversion should be better.
7. No litter to buy.
8. Produce eggs of uniform quality.

Disadvantages

1. Initial capital outlay is greater.
2. Cost of upkeep is greater.
3. Labour efficiency is not too good.
4. A year-round replacement program is necessary, hence year-round brooding.
5. A completely controlled ventilation system is necessary.

Houses

The majority of new laying-cage houses in Ontario are of pole-type construction about 24 feet wide which accommodate three rows of back-to-back cages (six rows). Usually a gravel floor is used for these houses. The building should be well insulated, and auxiliary heat should be available in severe weather. The double-tiered system seems to have much in its favour for northern climates. Doubling the number of birds housed reduces the housing cost per bird. Results in the mid-west indicate that this system will work without auxiliary heat. A method has now been worked out for removing droppings when a tiered system is used.

Cages

Two sizes of cages, 8 inches and 10 inches wide, are commonly used. The 8-inch cage allows more birds to be housed, but a small strain of bird must be used. The cages are usually 22 inches from back to front of egg



Fig. 31—A laying-cage house for approximately one thousand birds; ramp at the end of building is for loading manure.

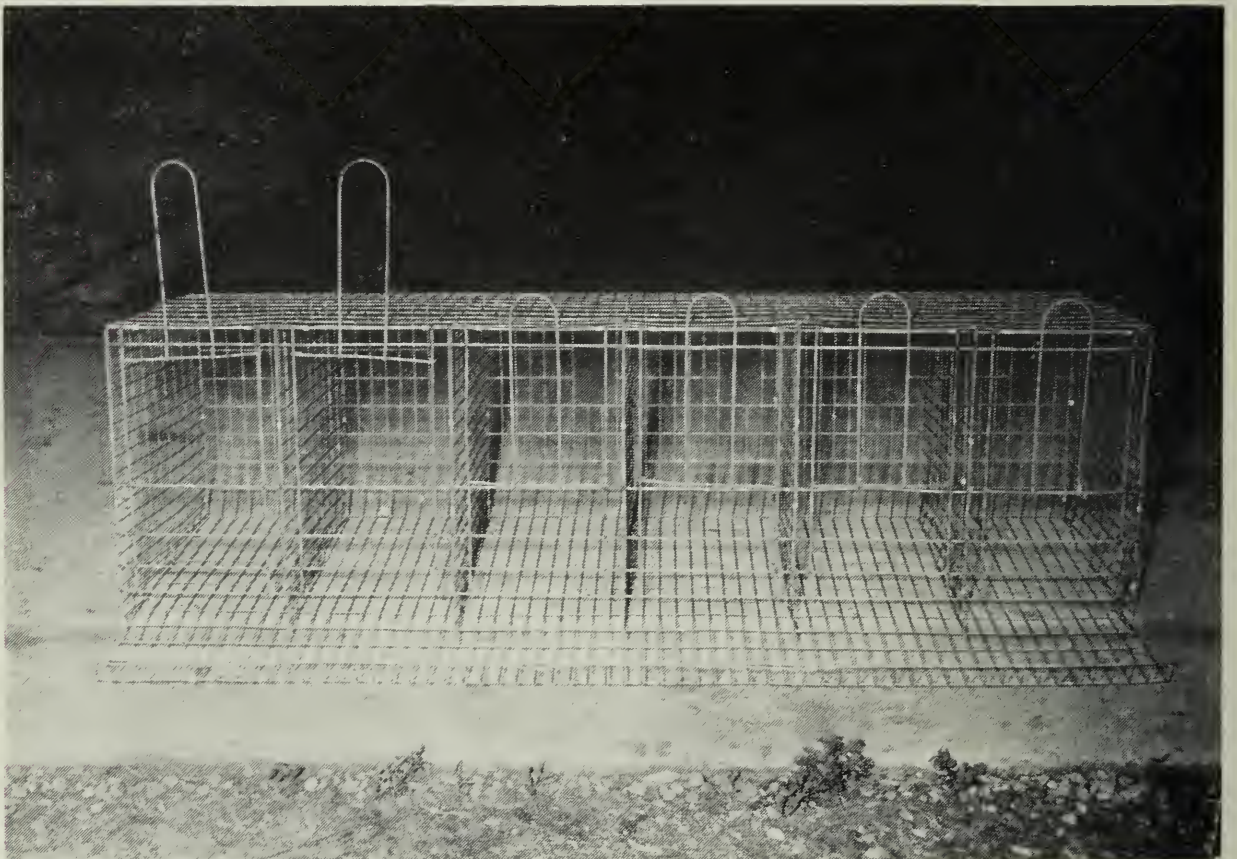


Fig. 32—A section of ten-inch cages just being assembled.

trough and 16 inches high. The cost per cage varies with makes but is approximately \$1.35.

Lights

A minimum of one 25-watt bulb is required for each 12 feet of aisle (place bulbs over aisles). The bulbs should be staggered in the aisles for uniform lighting.

Twelve to fourteen hours of light daily should promote maximum production. As birds in cages cannot move to avoid drafts, it is essential that all windows fit tightly in winter.

Program

There are two ways to get started: buy started pullets, or buy chicks and raise your own. In either case, make sure you get a strain of birds of proven ability in cages. Twelve hundred pullet chicks should be started for each 1,000-cage capacity.

Every three months 200 pullet chicks per 1,000 cages should be started as replacement stock. Because this will vary slightly with individuals and strains, the exact replacement program must be worked out by the individual.

Some grow the replacement stock on the floor, others on wire. By three months of age, however, they should be placed in cages so the adjustment can be made before production starts.

Culling

Each operator should know his costs to produce one dozen eggs and set his production standard accordingly. If eggs are gathered once a day and a card system is used, it is faster to mark the days a bird does not lay. If the clothes peg system is used, the peg is simply moved over one square each day the bird does not lay. The advisability of culling is questionable during the first six months, except on a health basis. In addition to these records, it helps the operator to have a card attached to each cage with the date the hen was hatched, breeding, date she started to lay, and broodiness.

Feeding

Since birds in cages do not get much exercise, they require less energy than layers kept on the floor. They require only about half the

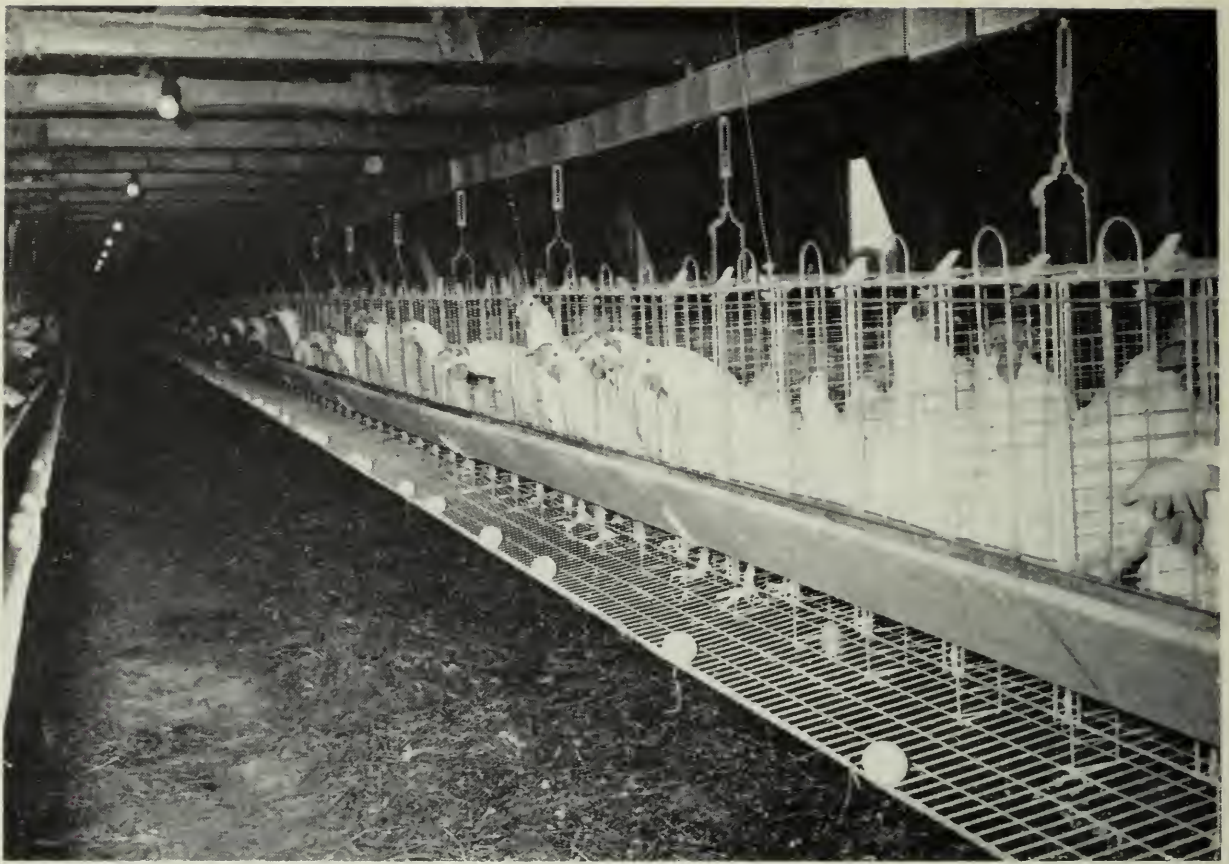


Fig. 33—A single-tier cage arrangement. Note lights and records above cage.



Fig. 34—A double-tier cage setup. Not as popular as single tiers because of extra labour.

grain that birds on the floor would need. To overcome the necessity of feeding whole grain, most caged layers are on an all-mash feeding program. The feed companies have developed special rations for caged layers, and it is wise to follow their feeding program.

Oyster shell may be fed twice a week on top of the feed, but more commonly it is incorporated in the feed in the form of calcium carbonate. Hens after several months of heavy production may require extra calcium, and it is doubtful whether they would eat sufficient oyster shell to supply their needs. The addition of calcium carbonate in the diet overcomes this difficulty and, therefore, is a definite advantage and labour-saver.

Insoluble grit may be fed once a week but, when an all mash ration is used, good results have been obtained with no grit.

Water

A constant supply of cool fresh water must be available for each bird. Various watering systems are in use with cages, the most common being the V-type trough.

Fly Control

In hot weather flies can become a serious problem unless a regular control program is followed. Flies do not multiply rapidly in dry manure. Thus the basis of one program is to keep the manure dry. To do this, it is preferable to have a gravel or sand floor covered with several inches of litter beneath the cages. The droppings are then built up in a cone, which dries rapidly because it allows good air circulation. The house should be cleaned out after the fly season is over.

A more popular method is to clean out the house regularly, in some cases once a month. This prevents a rapid buildup in the fly population.

Regardless of the system, the interior of the house should be sprayed with a suitable insecticide at about two-week intervals, or more often if necessary, to keep flies under control.

External Parasites

In spite of the wire cage and metal feed troughs, external parasites may develop into a heavy infestation. A regular inspection of the hens should be made for lice and northern fowl mites. The common red mite, if present, will be found on the under side of the feed and water troughs.

Control methods described previously will work with cages.

Dubbing

The Leghorn-type birds with their big combs are the type commonly used in cages. With the comb hanging over one eye, it frequently happens that the attendant will walk unnoticed down the aisle to this bird. His sudden appearance frightens the bird with the result that it flies up, hitting the top of the cage; a wave of fright may go through the entire house. This tends to make a more nervous flock and may affect production.

The solution is to dub the pullets and assure vision from both eyes. The best time to do this is when the chicks are taken from the incubator. Manicure scissors may be used, clipping the comb close to the head. There is no ill effect on the chick, with blood appearing on very few. Dubbing may also be done when the pullets mature, but this is a slower and messy job. At this time shears must be used, and powdered alum or some cauterizer should be applied.

Beak Clipping

Cages prevent losses from cannibalism but do not always prevent feather-picking. A bird can reach through the cage far enough to get hold of the feathers on the neck and breast of the adjacent bird. This results in poor appearance at the time the birds are sold and can make quite a difference in price. Some cage operators believe that the removal of the upper beak with an electric cauterizer is well worth the extra expense to overcome this condition.

Group or Colony Laying Cages

This type of laying cage is not commonly used in this area. The cage itself varies in size from one 3 by 5 feet holding 15 to 20 birds to larger units holding about 40 layers. The general construction and height is quite similar to the individual cages. The floor requires reinforcing, and this sometimes results in more cracked eggs than are found with the individual cages.

The Advantages Over the Single Cage

1. A lower unit cost per bird.
2. The birds have more freedom and, therefore, get some exercise.
3. The hens, being in a group, can stand a cold spell better.

The Disadvantages

1. Culling can not be carried out accurately.
2. No replacement program can be used to keep cages at maximum capacity. A single bird can not be replaced; rather, the whole unit must be replaced.
3. Cannibalism may be a serious problem.

MANAGEMENT FOR MARKETING TOP QUALITY EGGS

The best quality eggs are laid by pullets when they first come into production. The shell is strong, the albumen thick—an excellent egg for poaching. Hens which start laying after coming through a moult also lay good quality eggs with strong shells. As a rule, the longer a hen lays, the poorer quality egg she produces. The quality can deteriorate in some strains or crosses after heavy production to such an extent that the grade is seriously affected. The shells become very weak, and the percentage of thin white increases until even fresh eggs, when broken out, are running and flatten out in the pan, not unlike a stale egg.

Breeding is definitely a factor in egg quality; some strains and crosses are bad, while others are reasonably good. It is becoming such a problem at the present time that the breeders are going to have to give it consideration, and the commercial egg producer should definitely look for stock that continues to produce good quality eggs after 10 to 12 months lay, or even longer.

Breeding is not the only factor involved in egg quality. Nutrition doubtless plays an equally important part. The nutritionists have learned how to feed hens for egg production, but not for egg quality.

Some diseases and faulty management are two other causes of poor quality eggs.

The percentage of top quality eggs marketed usually drops with the arrival of hot weather. However, since almost 100 per cent of newly laid eggs are of top quality, the drop in quality can be blamed primarily on poor management.

To begin with, a flock of layers should be confined; otherwise, dark yolks and strong-flavoured eggs may result from the extra green feed, etc., that the birds pick up. Next, the eggs must be gathered often—three or four times daily—particularly in the hot weather. Eggs will deteriorate noticeably in a few hours if exposed to high temperatures.

The production of clean eggs is another factor which is important and is tied in with good housing. Broken eggs would also come in this classification, and often carelessness on the attendant's part when gathering eggs results in more breakage and soiled eggs. Do not put cracked or thin-shelled eggs in the basket with clean eggs; instead have a smaller basket hooked on the larger basket for these eggs. After gathering the eggs, do not hang them on a nail near the ceiling, which is probably the warmest part of the pen. Do not leave a basket in the feed room, as it will only collect dust and it also will be too warm.

Immediately after gathering, take the eggs to some cool clean room where a temperature of about 50° to 55°F. and a humidity of about 60 per cent may be maintained. Most farm basements meet these requirements. The eggs should then be left in a plastic-covered wire basket or placed in egg trays until cooled. Then pack in egg cases, after making sure that all dirty eggs are cleaned.

Eggs may be cleaned in several ways. If only a few are dirty, they may be dry-cleaned with the use of an abrasive-type buffer. Wiping with a damp cloth is another way of removing small soiled areas. For the extremely dirty eggs, it is probably simpler to soak them in water for a few minutes.

When eggs are washed, it is essential to keep the water clean by changing it frequently. The water temperature should be approximately 115°F. and the eggs washed for three to four minutes. The equipment used must also be kept clean. Using dirty water or equipment may result in rots, etc., developing in the egg. Various types of egg washers and dry cleaners are manufactured. These are generally used for larger poultry plants; again, the need for keeping this equipment clean should be stressed.

The eggs should be taken to the grading station at least twice a week. If the eggs are picked up at the farm and have a long distance to travel over rough roads or under a hot tarpaulin, quality is bound to suffer. In this case it probably pays to deliver the eggs directly.

While the bulk of eggs are sold to grading stations, many successful retail businesses have been developed. In order to maintain this type of business and hold customers, a steady year-round supply of a quality product is essential. This may mean a major change in the flock program to accommodate the additional enterprise.

Various methods of retailing are used by producers, but those most successful are usually near thickly populated areas. The sale of eggs and poultry at public markets is a popular retail outlet for the produce. The establishment of a weekly egg route is another outlet, but it requires considerable time to operate.

For farms located on busy highways, an attractive roadside sign will sell a lot of produce. While a roadside stand is suitable for fruit and vegetables sales, eggs and poultry kept in these stands are not top quality unless refrigeration is available.

The Poultry Marketing Service of the Canada Department of Agriculture administers regulations regarding the grading and sale of poultry products. In order to conform with regulations, Ontario producers who contemplate retailing their poultry products should contact the Poultry Marketing Service, Room 925, 25 St. Clair Avenue E., Toronto 7, Ontario.



